

# 7150plus Digital Voltmeter MAINTENANCE MANUAL

**Schlumberger**

**Technologies**  
Instruments Division

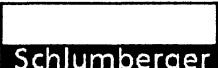
# 7150plus

## Digital Multimeter

### MAINTENANCE MANUAL

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 Schlumberger

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Schlumberger pursue a policy of continuous development and product improvement.  
The specification in this document may therefore be changed without notice.

## SAFETY PRECAUTIONS

The equipment described in this manual has been designed in accordance with IEC publication 348 (Class 1) Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. To avoid injury to an operator or service technician the safety precautions given below, and throughout the manual, must be strictly adhered to, whenever the equipment is operated, serviced or repaired. The equipment is designed solely for electronic measurement and should be used for no other purpose. Schlumberger accept no responsibility for accidents or damage resulting from any failure to comply with these precautions.

### GROUNDING

To minimize the hazard of electrical shock it is essential that the equipment is connected to a protective ground whenever the power supply, measurement or control circuits are connected, even if the equipment is switched off. The protective ground for ac and dc supplies is connected separately.

AC GROUND is connected via the ac supply cord. The cord should be plugged into an ac line outlet with a protective ground contact. When an extension lead is used, this must also contain a ground conductor. Always connect the ac supply cord to the supply outlet before connecting the control and signal cables; and, conversely, always disconnect control and signal cables before disconnecting the ac supply cord. The ac ground connection should be capable of carrying the potential ac fault current, i.e. 6A.

DC GROUND is connected via a ground stud on the equipment power supply unit (PSU). This must be connected to a suitable ground, capable of carrying the potential dc fault current, i.e. 35A.

Where both protective grounds are used it must be ensured that these grounds are, and will remain, at the same potential.

### AC SUPPLY VOLTAGE

Before switching on the equipment ensure that the ac voltage selector is set to correspond with the local ac supply voltage. (See installation instructions in Operating Manual.)

Never operate the equipment from a line voltage or frequency in excess of that specified for the voltage selector setting used. Otherwise, the insulation of internal components may break down and cause excessive leakage currents.

### FUSES

Before switching on the equipment check that the fuses accessible from the exterior of the equipment are of the correct rating. The rating of the ac line fuse must be in accordance with the voltage of the ac supply. (See installation instructions in operating manual.)

Should any fuse continually blow, do not insert a fuse of a higher rating. Switch the equipment off, clearly label it "unserviceable" and inform a service technician.

### EXPLOSIVE ATMOSPHERES

NEVER OPERATE the equipment in a potentially explosive atmosphere. It is NOT intrinsically safe and could possibly cause an explosion.

*Continued overleaf.*

## SAFETY PRECAUTIONS (continued from previous page)

### SAFETY SYMBOLS

For the guidance and protection of the user, the following safety symbols appear on the equipment:

SYMBOL	MEANING
	Refer to operating manual for detailed instructions of use.
	Hazardous voltages.
	Protective conductor terminal. This must be connected to ground before operating the equipment.

### NOTES, CAUTIONS AND WARNINGS

For the guidance and protection of the user, Notes, Cautions and Warnings appear throughout the manual. The significance of these is as follows:

**NOTES** highlight important information for the reader's special attention.

**CAUTIONS** guide the reader in avoiding damage to the equipment.

**WARNINGS** guide the reader in avoiding a hazard that could cause injury or death.

### AVOID UNSAFE EQUIPMENT

The equipment may be unsafe if any of the following statements apply:

- The equipment shows visible damage.
- The equipment has failed to perform an intended operation.
- The equipment has been subjected to prolonged storage under unfavorable conditions.
- The equipment has been subjected to severe physical stress.

*If in any doubt as to the serviceability of the equipment, don't use it. Get it properly checked out by a qualified service technician.*

### LIVE CONDUCTORS

When the equipment is connected to its measurement inputs or supply, the opening of covers or removal of parts could expose live conductors. The equipment must be disconnected from all power and signal sources before it is opened for any adjustment, replacement, maintenance or repair. Adjustments, maintenance or repair, must be done only by qualified personnel, who should refer to the Maintenance Manual.

### EQUIPMENT MODIFICATION

To avoid introducing safety hazards, never install non-standard parts in the equipment, or make any unauthorized modification. To maintain safety, always return the equipment to Schlumberger for service and repair.

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# Chapter 1

## General Information

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## 1 GENERAL

The '7150plus' Digital Multimeter (DMM) is suitable for general-purpose bench applications and for systems use. It performs all common measurement functions and has a scale length in excess of 200000. The DMM has a built-in GP-IB Systems Interface which conforms with the internationally recognised IEEE 488 (1978) standard, thus ensuring the compatibility of 7150plus with a wide range of system devices produced both by Schlumberger and by other manufacturers.

The DMM is designed to be calibrated 'digitally', either via the front panel controls or via the GP-IB Interface. The DMM's built-in facilities obviate the need for special tools and mechanical strip-down, thus significantly reducing calibration down-time.

## 2 SAFETY

The 7150plus has been designed in accordance with the recommendations of IEC348. To ensure the user's safety and the continued safe operation of the DMM, the user is advised to read carefully the procedures and specifications given in the Operating Manual and this Maintenance Manual.

**Care should always be exercised whenever the input leads are being connected or removed especially where high voltages are known to exist or high transients occur.**

The DMM is protected against measurement overload, up to 1.2kV peak on voltage measurement and 240V rms on resistance measurements.

When using the DMM on equipment which is capable of delivering high voltages (eg, inductive circuitry giving high back-emfs) it is strongly recommended that the equipment under test is **not** switched off while the DMM is still connected. The DMM leads should be carefully disconnected before switching off the equipment, this will help to prevent the hazards of back-emfs. The following example illustrates this. Consider the inputs connected across the secondary of a large mains transformer. The very high input impedance of the DMM is such that in the event of the mains supply being interrupted, the resultant back emf induced in the undamped secondary could be in the order of 100kV. This is obviously hazardous to the user and would certainly damage the DMM. User safety may be preserved by the inclusion of a switch between the DMM and the transformer secondary. The switch could then be switched on and off while the transformer remained powered.

Whenever it is likely that the safety of the DMM has been impaired - eg, if it shows visible signs of damage, if it fails to perform correctly, or if the specifications have been exceeded in any way - it should be made inoperative and referred to a suitable repair depot.

Any maintenance, adjustment or repair of the DMM must only be carried out by skilled personnel. Such adjustment, maintenance or repair should be carried out in accordance with the procedures and precautions detailed in this Maintenance Manual.

## 3 SCHEDULED MAINTENANCE

The DMM should be calibrated annually (see Chap. 3 of this manual for calibration details). No further scheduled maintenance is necessary.

## 4 ACCESSORIES

The following accessories may be used with the DMM:

- Radio Frequency Probe (Part No.70457F)
- High Voltage Probe (Part No.70457E)
- 10A Current Shunt (Part No.70457X)
- Temperature Probes:
  - Insertion Probe (71517A)
  - Surface Probe (71517B)
- Rack Mounting Kit (Part No.71501)

Instructions in the use of the accessories and for fitting the Rack Mounting Kit are given in the associated Operating Manual, Part No.71500024

## 5 PRINTED CIRCUIT BOARDS

The following three printed circuit boards, identified respectively as pcbs 1, 22 and 3, are fitted to the DMM:

- Pcb 1 - Floating Analog and Logic , Part No. 71510501.
- Pcb 22 - Earthy Logic , Part No. 71500522
- Pcb 3 - Display and Keyboard, Part No. 71500503.

There is no separate pcb for the dc power supplies, this circuit is distributed between pcb 1, pcb 22 and the rear panel. A circuit diagram of the dc power supplies is given in Chapter 2.

## 6 IEEE 488/GP-IB OPERATION

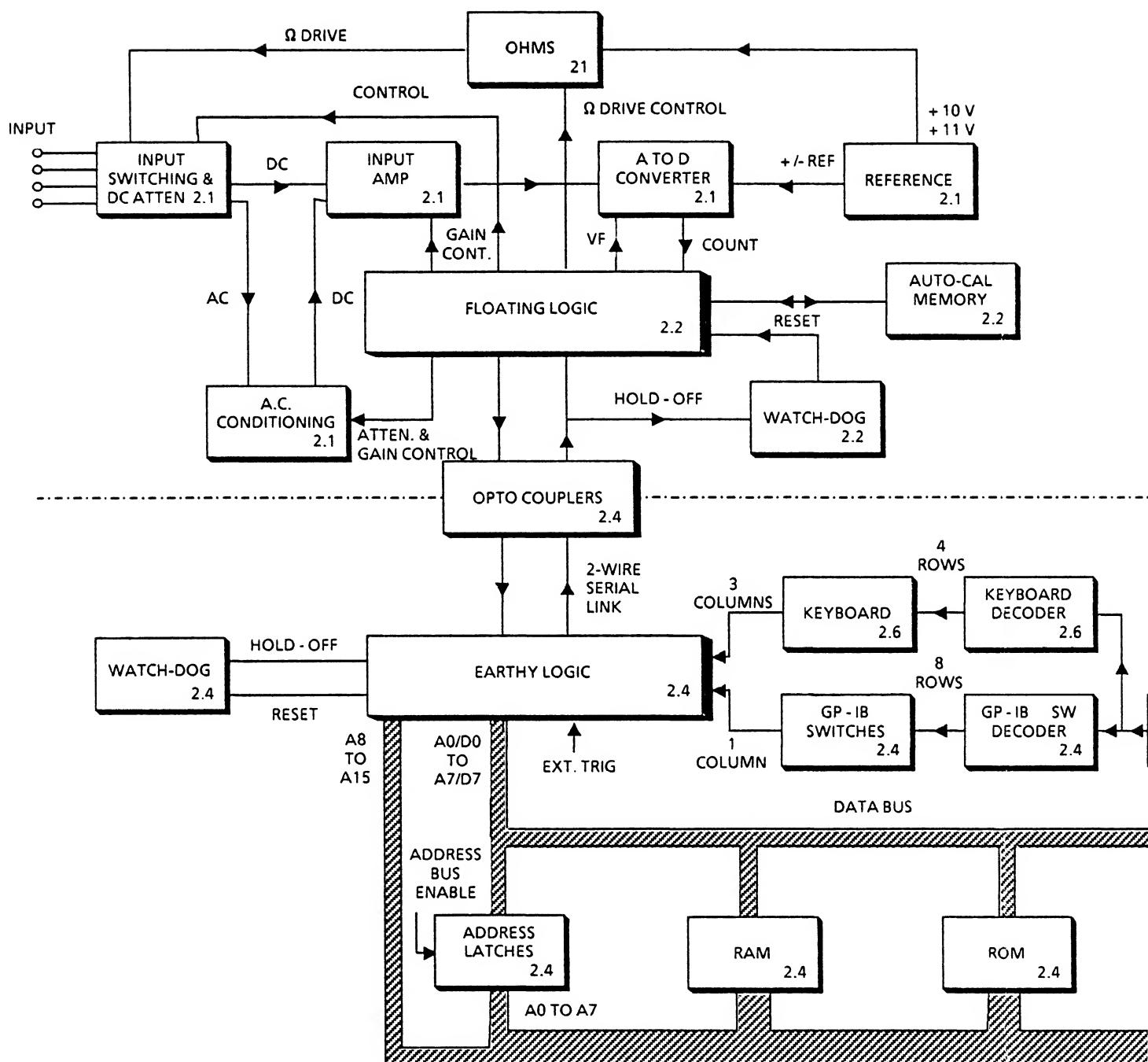
The operation of the DMM in conjunction with the IEEE 488 interface bus is described in the 7150plus operating manual. Part 2 of the operating manual contains example programs for controlling the DMM using various types of controller.

## 7 DMM - SUMMARY OF OPERATION

A functional block diagram of the DMM is shown in Fig 1.1. The 'pulse-width' analog-to-digital (A-to-D) conversion technique is used in the DMM. The DMM is basically a voltage measuring instrument. The resistance and current range inputs are converted to a dc voltage and suitably scaled in the signal conditioning circuits prior to A-to-D conversion. The input analog and A-to-D conversion circuits are contained in the 'floating' section of the DMM.

The A-to-D converter produces two balanced pulse trains at its output. Any measured input causes the pulse width of one of the trains to increase, with a proportionate decrease in the width of the other. These outputs, converted into a single pulse train and synchronised to clock, are used to gate clock into a reversible counter within the MPU. The nett result is a count which is proportional to the measure of input.

Power supplies for the DMM are derived from conventional mains operated dc supplies.



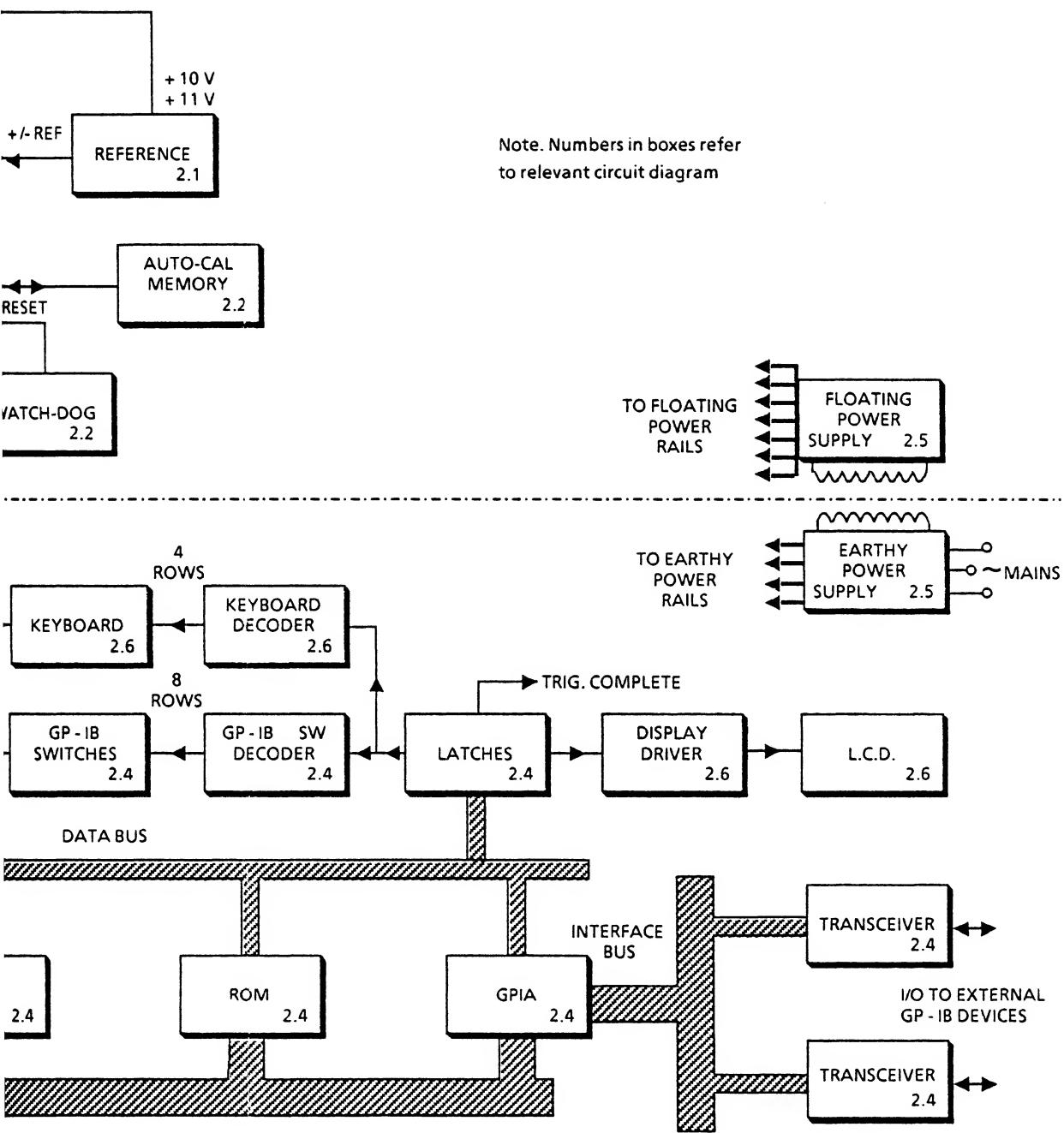


Fig 1.1 7150plus FUNCTIONAL BLOCK DIAGRAM

# Chapter 2

## Circuit Descriptions

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## 1 DC VOLTAGE MEASUREMENT (Diag. 2.1)

All DMM inputs, including dc voltage inputs, are processed by the Analog-to-Digital Converter (ADC). The operating range of the ADC is limited to  $\pm 2.6V$ . The measurement range of the DMM is extended beyond these limits by scaling all inputs to the 2 volt range. For example, a 200V input scaled by a factor of 0.01 would be seen by the ADC as only 2V.

In practice scaling (or signal conditioning) is a two-stage operation performed by the dc input attenuator (for dc volts) and the input amplifier IC1A. The input amplifier is described on page 2.7.

The dc voltage input circuit has two main functions:

1. Signal conditioning,
2. Input switching, to the input amplifier.

### 1.1 SIGNAL CONDITIONING

The dc voltage input attenuator consists of resistors, R1A to R1D. The attenuator is switched by FETs TR7, TR8 and relay RLK in response to range control inputs from the floating logic. The attenuator setting, either  $\times 1$ ,  $\times 0.01$  or  $\times 0.001$ , depends upon the selected voltage range ie:

Range (V)	Attenuation	Circuit Path
0.2	$\times 1$	Direct to Input Amp via RLB contact
2.0	$\times 1$	(as above)
20	$\times 0.01$	RLK contact, TR7, with RLB contact open
200	$\times 0.01$	(as above)
1000	$\times 0.001$	RLK contact and TR8, with RLB contact open

The attenuated outputs are amplified by the input amplifier. The gain of the amplifier is arranged to be either  $\times 1$  or  $\times 10$  in order to ensure satisfactory scaling at the ADC.

### 1.2 INPUT SWITCHING

DC voltage inputs to the input amplifier are selected via series FET TR5. When TR5 is ON, shunt FET TR6 is OFF and vice versa. TR6 is switched ON during ac voltage or current measurement and also during dc current measurement. (An additional function of TR6 - during a 'drift correct' - is described on page 2.7).

## 2 AC VOLTAGE MEASUREMENT (Diag. 2.1)

In Vac operating mode, inputs are first scaled to the 2 volt range by the ac signal conditioning circuits and then converted into a dc voltage. Mode control signals then switch the converted output to the dc input amplifier. A-to-d conversion follows in the manner described on page 2.8.

### 2.1 SIGNAL CONDITIONING

AC voltage signal conditioning is performed by the ac input attenuator and by Operational Amplifier IC15. The attenuator is switched by IC18, TR1 and TR2. The gain of IC15 is set via IC18 to be either  $\times 1$  or  $\times 10$ .

For inputs on the lower two ranges (0.2V and 2V) no conditioning is required. Quad analog switch IC18 selects the gain of IC15 (via matched resistors R21A and R21B) to be at unity, with inputs to the amplifier connected direct via RLA, RLE, and RLF contacts. The overall circuit gain for other input ranges is selected by TR1 and IC18 in response to range and control inputs from the floating logic. Details are as follows:

Range (V)	Attenuation	Amp I/P (V)	Gain	Amp O/P (V)
0.2	$\times 1$	0.2	$\times 10$	2.0
2.0	$\times 1$	2.0	$\times 1$	2.0
20	$\times 0.01$	0.2	$\times 10$	2.0
200	$\times 0.01$	2.0	$\times 1$	2.0
1000	$\times 0.001$	1.0	$\times 1$	1.0

### 2.2 AC-DC CONVERSION

AC to DC conversion is carried out by true rms-to-dc converter IC21. The maximum 2V output from this IC is switched to the dc input amplifier IC1 via the shunt input FET TR6 via quad analog switch IC5.

### 3 RESISTANCE MEASUREMENT (Diag. 2.1)

Resistance measurement is achieved by measuring the voltage developed across the unknown resistance when a known current is passed through it. The resultant voltage is then measured by the dc voltage measurement circuit.

#### 3.1 CURRENT GENERATOR CIRCUIT

IC3 is a precision operational amplifier which is connected to +10 volts from the reference supply circuit. The other amplifier input is a +11 volts reference supply. Thus IC3 will drive TR3 to maintain a 1 volt differential across R73, R74, R75 and R15.

Control inputs from the logic circuitry switch this resistor chain (via TR4, TR9 and RLD) to define one of four test currents. The test current made available depends upon the selected resistance range, ie.:

Nominal Range	Test Current
20MΩ	100nA
2MΩ	1μA
200kΩ	10μA
20kΩ	100μA
2kΩ	100μA

#### 3.2 FOUR-WIRE RESISTANCE CHECKS

During four-wire resistance checks, all of the current available at the Hi Ω Source terminal should be returned to source via the LO Ω Source terminal.

On the lower resistance ranges (2MΩ, 200kΩ, 20kΩ and 2kΩ) the logic control, via IC2, also switches the resistor chain R7, R27 and R56 which is connected to the Lo source terminal and to the -3V reference supply. This part of the circuit acts as a calibrated current sink for the test current generator.

#### 3.3 INPUT PROTECTION

Input protection for the resistance measurement circuit is provided by resistor R4 (22kΩ) which is in series with both I+ and V+ input terminals. Diodes D2 and D25 limit the voltage at the junction of TR3 and R4 to +5.3 and -2.6V

## 4 CURRENT MEASUREMENT (Diag. 2.1)

Current measurement is achieved by measuring the potential across a known resistance when the current to be measured flows through it. The voltage thus obtained is measured by the dc input amplifier either direct, or for ac inputs, via the AC-DC converter.

### 4.1 DC CURRENT INPUT

Resistor R3 is a  $0.1\Omega$  shunt resistor through which the current to be measured flows. The potential across R3 is switched to the dc input amplifier IC1 via quad switch IC5 and shunt FET TR6. The gain of IC1 is set to  $\times 10$  in dc current mode; the amplifier output is thus correctly scaled on the 2 volt range for A-to-D conversion.

### 4.2 AC CURRENT INPUT

In ac mode, the potential across shunt resistor R3 is switched, via quad switch IC18 and FET TR2, to the ac operational amplifier IC15. The gain of this amplifier is set to  $\times 10$  in ac current mode, thus the inputs to the AC-DC converter are scaled to the 2 volt input range.

After AC-DC conversion, the output voltage is switched to the dc input amplifier via quad switch IC5 and shunt FET TR6.

### 4.3 PROTECTION

Current overload protection is by 2 amp fuse, F1.

## 5 INPUT AMPLIFIER (Diag. 2.1)

Input amplifier IC1 is a precision FET input operational amplifier. Signals for IC1 are first amplified by the dual FET preamplifier TR13 whose bias is provided by transistor TR14 and diode D7.

Inputs to the preamplifier depend on the selected DMM function which in turn controls the action of FETs, TR5 and TR6. Either TR5 (series FET), or TR6 (shunt FET), is switched on. For dc measurement functions, including resistance, TR5 conducts. For ac functions, TR6 conducts. (See also the function of the FETs during drift corrections)

The gain of the preamplifier is controlled by IC2 in response to range control signals from the floating logic. IC2 is a quad analog switch connected across IC1 feedback resistors R18 and R19. The switching of IC2 sets the overall gain of the preamplifier and IC1 to be either X1 or X10 depending on the selected input range or measurement function. Gain settings are summarised as follows:

DC Voltage Ranges (V)	Gain
0.2	x 10
2	x 1
20	x 10
200	x 1
1000	x 1

DC Current Range (mA)	Gain
2000	x 10

AC Current Range (mA)	Gain
2000	x 1

### 5.1

#### DRIFT CORRECT

A correction for drift (a 'drift correct') is necessary in order to compensate for any drift originating in the input amplifier or from the A-to-D Converter. Typically, drift results from component aging or from variations in temperature.

During a drift correct, the input amplifier is isolated from any measured input by switching off series FET TR5. The amplifier input is then connected to signal 0V via shunt FET TR6 (on) and quad analog switch IC5. With zero input to the amplifier, any resultant count must be due to drift. This is subsequently subtracted from a measurement count to provide a final count (ie, the result) which is free from error.

A 'timed' drift correct is carried out automatically every 10 seconds; further drift corrections are made after a change of mode, range, or integration time.

With the multimeter in remote, a timed drift correct can be controlled using command Yn (where n is an integer between 0 and 2). For more information on command Yn and other commands, refer to Part 2 of the 7150plus Operating Manual.

## 5.2 INPUT PROTECTION

Input protection against voltage overload for the input amplifier is by spark-gap SG2 (1400V Nom.) which is connected across the V Hi and Lo terminals. Resistors R9 and R25 form a current limiter and diodes D6 and D26 limit series inputs to the amplifier to  $\pm 2.6$  Volts.

## 6 ANALOG -TO-DIGITAL CONVERTER (Diag. 2.1)

The analog-to-digital converter (ADC) converts the analog output from the input amplifier into pulses. These are used to gate clock into a reversible counter in MPU IC103, to produce a count proportional to the measured input.

### 6.1 THE INTEGRATOR

Integrator IC8A has the following inputs connected to its summing point:

- The input to be measured.
- The forcing waveform.
- The + or - reference.

With zero input to the multimeter and a 300Hz forcing square wave applied continuously to the integrator, the output is driven alternatively positive and negative through the thresholds of the comparators, IC9 and IC10.

The states of the two comparators are followed by bistable IC11 which synchronises the two transitions to clock. Outputs from IC11 control analog switch IC16 which switches the + and - reference supplies (through 0V) to the integrator input. This closed loop feedback arrangement is such that irrespective of the input to the integrator, the output will always remain dynamically balanced about zero.

The + and - reference levels from IC11 are NANDded by IC17a to produce a single clock-synchronised pulse train. This output is connected to counting circuits in the MPU, IC103.

## 7 REFERENCE SUPPLY (Diag. 2.1)

This circuit generates the +10V and +11V supplies for the ohms current generator and the + and - 3.1V reference supplies for the A-to-D converter.

Reference diode D20, together with resistor network R38, R42, R17 and RV1 hold the input to IC4 at +3.1V. This input, via IC6A and IC16, is the + reference supply for the ADC whilst the inverted output from IC4 is the -3.1V reference supply. (All reference values are with respect to '0V ROME')

The + reference voltage is also used as the input to IC6b. This amplifier drives a current through R14, R57 and R16 in order to maintain the amplifier at balance. The resistor chain is tapped to provide the +10V and +11V reference voltages for the ohms current generator.

## 8 FLOWING LOGIC (Diag. 2.2)

This circuit includes the floating logic MPU, IC103. This IC communicates with the earthy logic MPU via a 2-wire optically coupled serial link. The circuit can be considered as having four separate functions:

1. Controls range and mode switching on the analog pcb.
2. Generates the forcing waveform for the ADC.
3. Counts the pulsed output from the ADC.
4. Stores calibration constants and checksum for use during auto-cal procedures.

### 8.1 ANALOG CONTROL LINES

These MPU outputs are connected to drivers, comparators and bi-lateral switches on the analog pcb. The outputs, via their respective switching devices, correctly configure the DMM circuits for the selected range and function.

### 8.2 FORCING WAVEFORM

The 'timer-out' signal from the MPU is a 300Hz waveform which is used to generate the forcing waveform for the ADC. The TTL level signal is converted into a 0 to 8V square wave by bi-lateral switch IC7 in the analog circuit.

### 8.3 COUNTING CIRCUIT

'Timer-in' is an input to the MPU which is derived from the ADC. The input is a single, clock synchronised pulse-train; the pulse widths indicating alternately, the length of time the + and - reference voltages were applied in order to balance the integrator. Within the MPU, these pulses are used to gate clock into a reversible counter to produce a nett count proportional to the measured input.

### 8.4 NON-VOLATILE MEMORIES

ICs 105 and 106 are EARMs which hold the automatic calibration program for the multimeter and the calibration constants for each mode/range selected.

### 8.5 FLOATING LOGIC RESET WATCHDOG

This circuit is responsible for controlling the reset state of the floating logic MPU IC103. The circuit operation is similar to that of the earthy logic reset circuit.

A 1.2288 MHz, clock derived output from the IC103 is divided by a 12-bit binary counter IC107. The 300Hz (3.333 ms period) output from this IC is counted by a 4-bit counter, IC108.

The serial link TX DATA line from the earthy MPU, is also connected, via split pad (SP) 1, to IC108. This input holds-off the RESET output to IC103 unless the RX DATA line to IC 103 becomes inactive for > than 26.666 ms (8 x period). On power-up, the circuit holds IC103 in reset for > 26.666ms and then releases the RESET line (ie, the line goes hi). With RESET released, IC103 will function.

The circuit also has a 'time-out' watchdog function which allows the earthy MPU, IC510, to reset IC103. During normal operations, IC510 will be in frequent serial dialogue with IC103 via pin 2 of IC102a. This signal also connects to the reset circuit via SP1 and providing there is activity on this line, the RESET line will remain

inactive. Should the signal at SP1 remain high for more than 26ms, the watchdog circuit will 'time-out' and put IC103 into the RESET state.

With the RESET line active, bistable IC11 (see ADC) is also reset, thus MPU pin 8 (TIMER IN) is set to a logic 1 state. Pins 8, 9 and 10 are set to this state at initialisation.

## 9 EARTHY LOGIC (Diag. 2.4)

The earthy logic includes the main microprocessor set (MPUset) the GP-IB interface, the interface switch decoders and the watchdog reset circuitry.

### 9.1 MPU SET

The MPU set comprises the following:

- IC510; 8-bit MPU.
- IC508; 16K x 8 bit PROM.
- IC506; 2K x 8 bit RAM.

### 9.2 GP-IB INTERFACE

The GP-IB interface has the following ICs:

- IC503; General Purpose Interface Interface Adapter (GPIA)
- IC502; Octal Transceiver
- IC501; Octal Transceiver

IC503 consists essentially of 15 registers, 7 of which can be written into by the MPU and depending on the state of control lines R/W and RS0 to RS2, eight can be read by the MPU.

Transceivers IC501 and IC502 are bidirectional, each consisting of eight driver/receiver pairs. Each driver/receiver is enabled by a send/receive input (TR/1 and TR/2) with the disabled output forced to a high impedance state. All GPIB signals are at TTL levels.

### 9.3 ADDRESS DECODERS

The MPU addresses the various bus connected devices and the watchdog reset circuit via 3-to-8 decoder IC512. The PROM (IC508) is separately addressed via address line A15 which, when active, deselects IC512. PROM IC508 is addressed separately via A15 (inverted) address line.

### 9.4 RESET WATCHDOG

A 1.2288MHz, clock derived output from MPU IC 510 is further divided by 12-bit binary counter IC516. The 300Hz (3.33ms period) output from This IC is counted by 4-bit binary counter, IC517.

With MPU IC510 functioning normally, IC 517 is loaded every 10 ms (decode \$4000) to hold off the reset output. Should pin 1 of IC 407 remain inactive for more than 26.64 ms (8 x period) then IC 517 output resets both the MPU and the display.

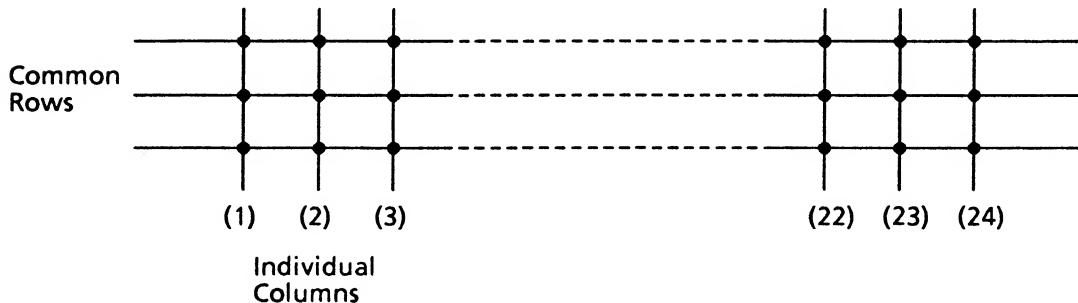
## 10 DISPLAY AND KEYBOARD (Diag. 2.6)

This circuit has two main functions:

1. To decode display and command data.
2. To transfer keyboard selections to the MPU.

### 10.1 DISPLAY

The display circuit includes custom LCD, X401. Electrically the LCD can be considered as being a set of 8, 3 x 3 matrices whose columns are separately controlled, but whose rows are common:



The intersections between the rows and columns form active elements which correspond to individual segments, decimal points, or annunciators that appear on the display. The display is driven by pulses that alternate about 0V; this ensures that the crystals do not become permanently polarised.

IC401 is the driver for the LCD. It is serially interfaced with IC510 (earthy logic MPU). Interconnect lines include SI (serial input), SCK (serial clock), CS (chip select), C/D (control data), BUSY, and RESET.

With CS pulled low, data may be sent on the SI line. The data are clocked bit-by-bit on each positive transition of SCK. On the eighth positive transition, the BUSY line is made active low by IC401 until it is ready to accept more data.

The serial input may simply be data for display, in which case the control data (C/D) line remains in its active low state. If however a driver command is sent, for example the command to blank the display or one to cause it to flash, then C/D will be set to the logic 1 state.

### 10.2 KEYBOARD

The (vertical) column outputs from the keyboard are connected directly to the MPU and, with no selections made, held in the logic 1 state via pull-up resistors on the earthy logic pcb. Keyboard (horizontal) rows are scanned via output latch IC511 and BCD-to-decimal decoder, IC402. Thus keyboard settings data are made available to the MPU.

## 11 POWER SUPPLIES (Diags. 2.3 and 2.5)

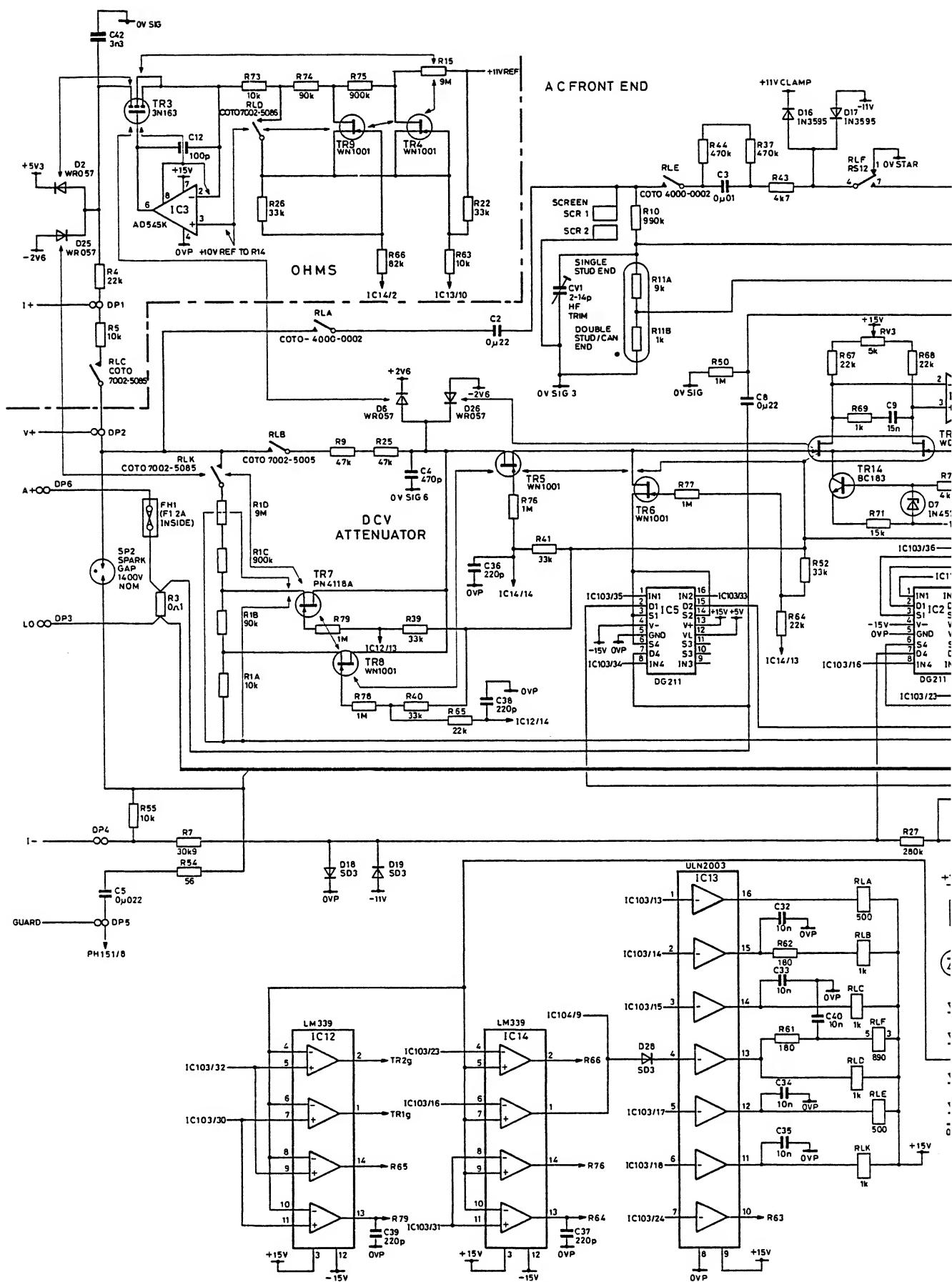
The power supply circuit provide both earthy and floating power for the multimeter. The circuit is distributed between pcb 1, and pcb 2, with a mains power input unit and a calibration (cal) enable switch are included on the rear panel.

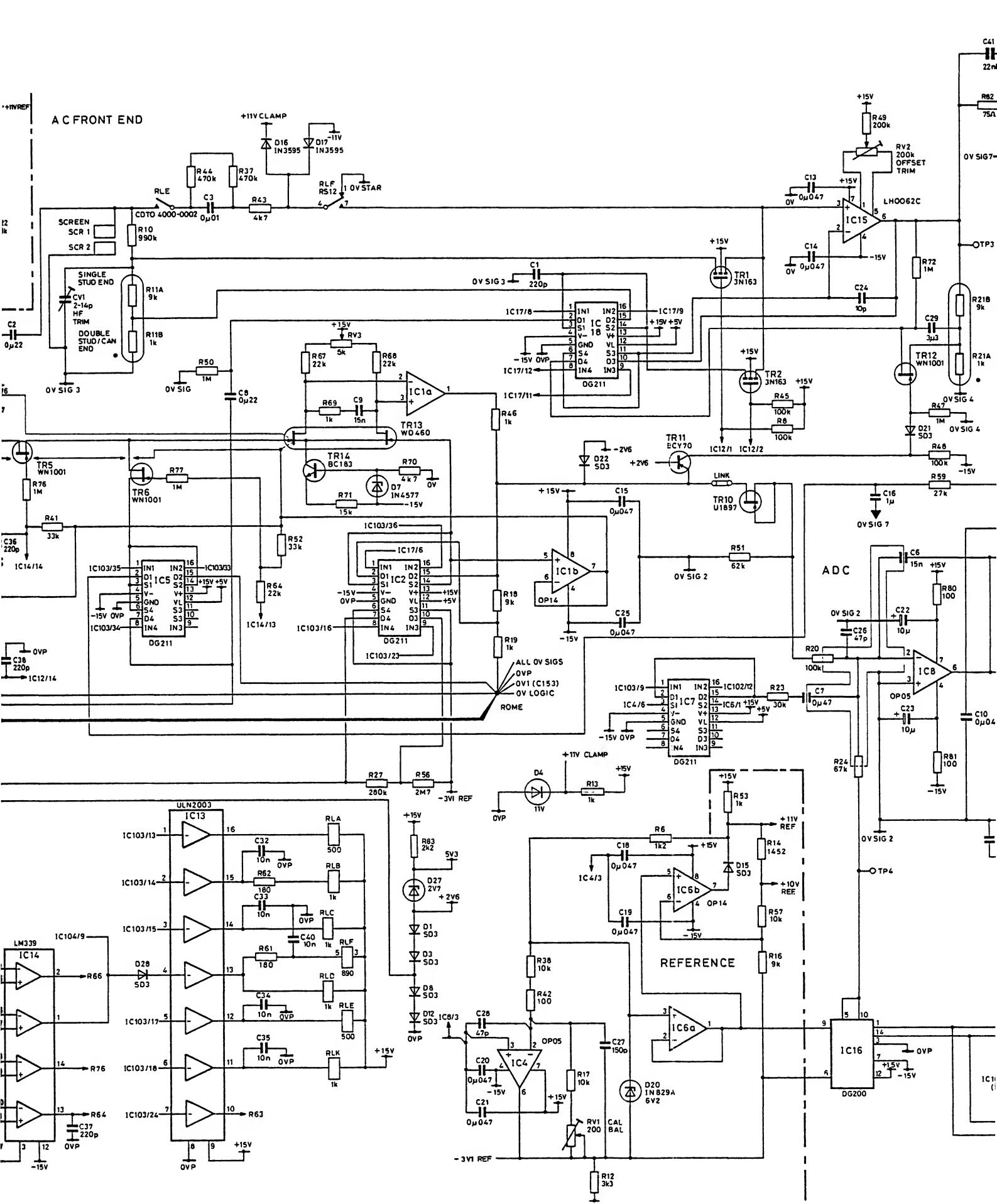
### 11.1 MAINS POWER INPUT UNIT

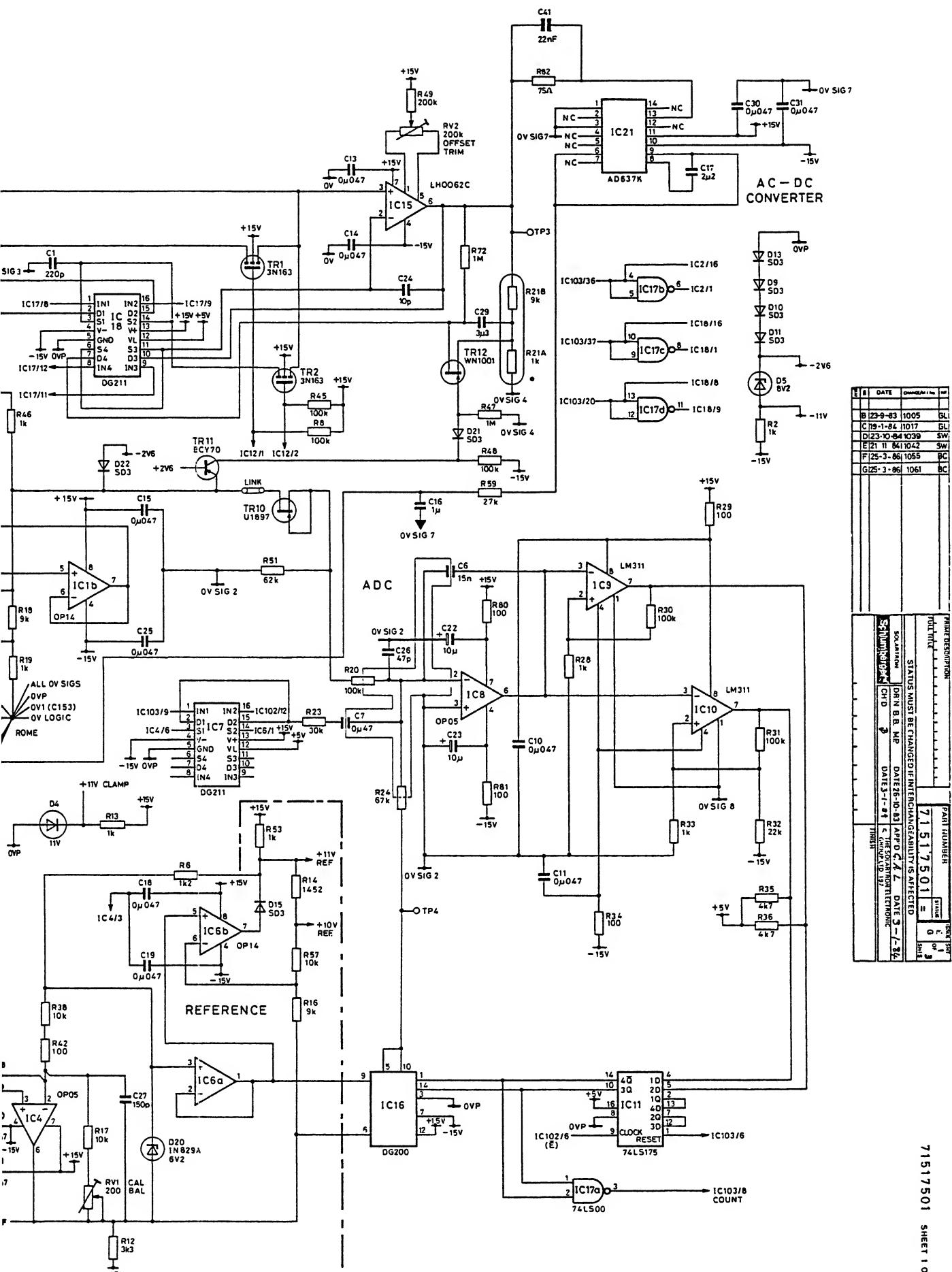
Contacts a to e within the mains power input, unit are set by positioning the voltage selector/cam assembly, to the required voltage setting as seen through the aperture at the rear of the DMM.

### 11.2 CAL ENABLE

IC306 acts as a switch for the -25V output. This supply, which is required by the auto-calibration EEPROMs, will only be made available when the transistor conducts, ie, when the calibration jack-plug is inserted. This is to prevent unauthorised interference to calibration coefficients.

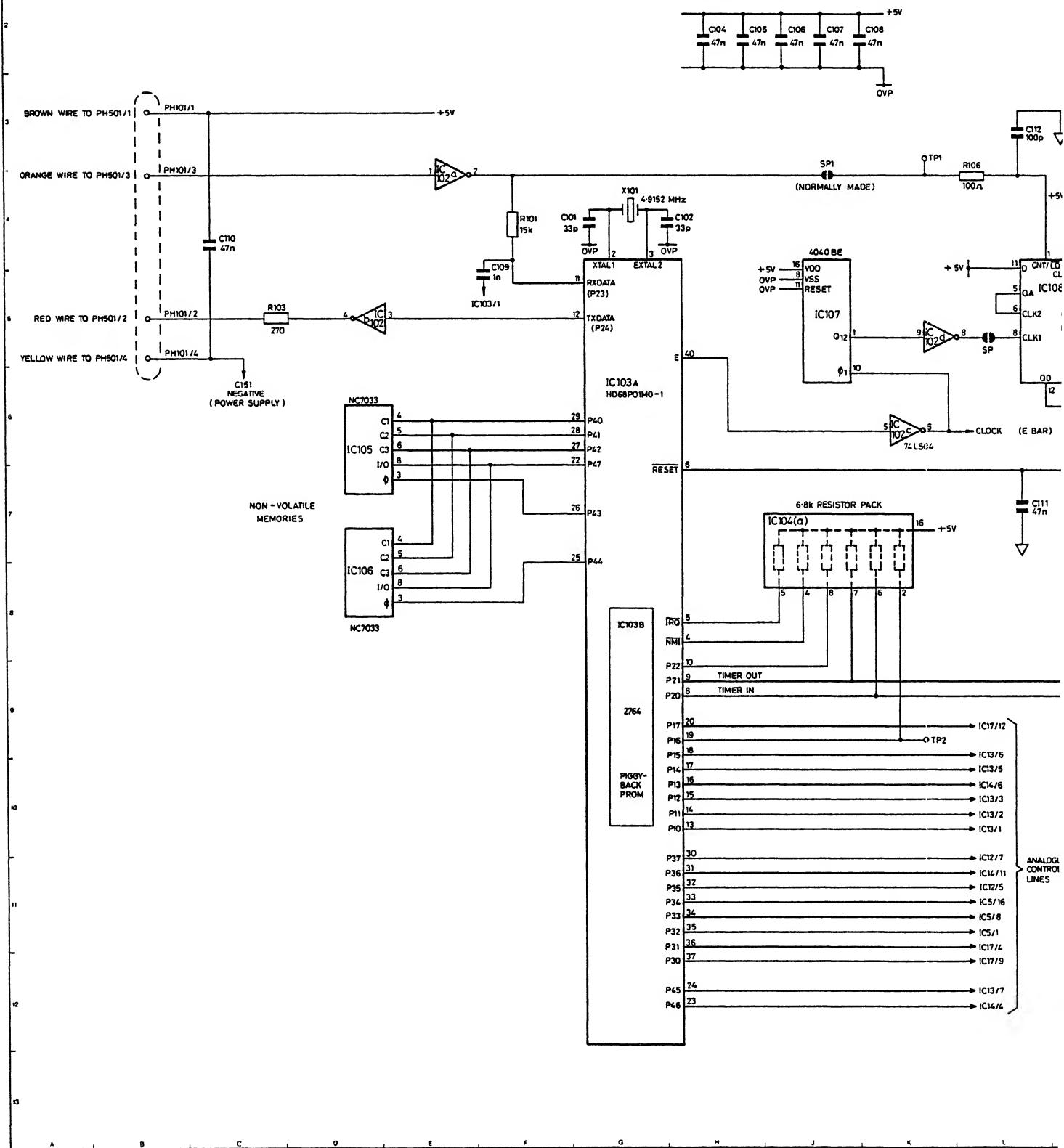


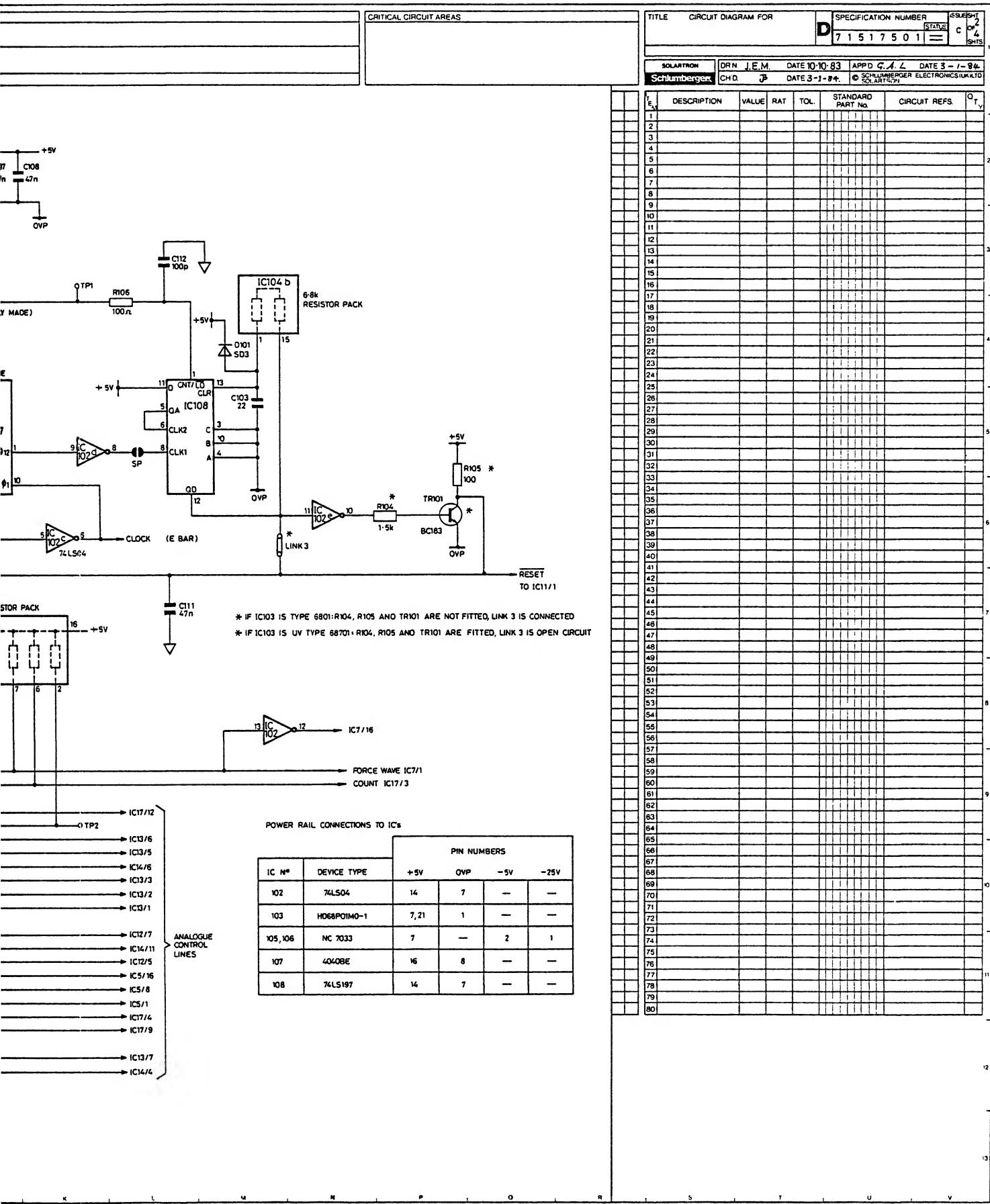


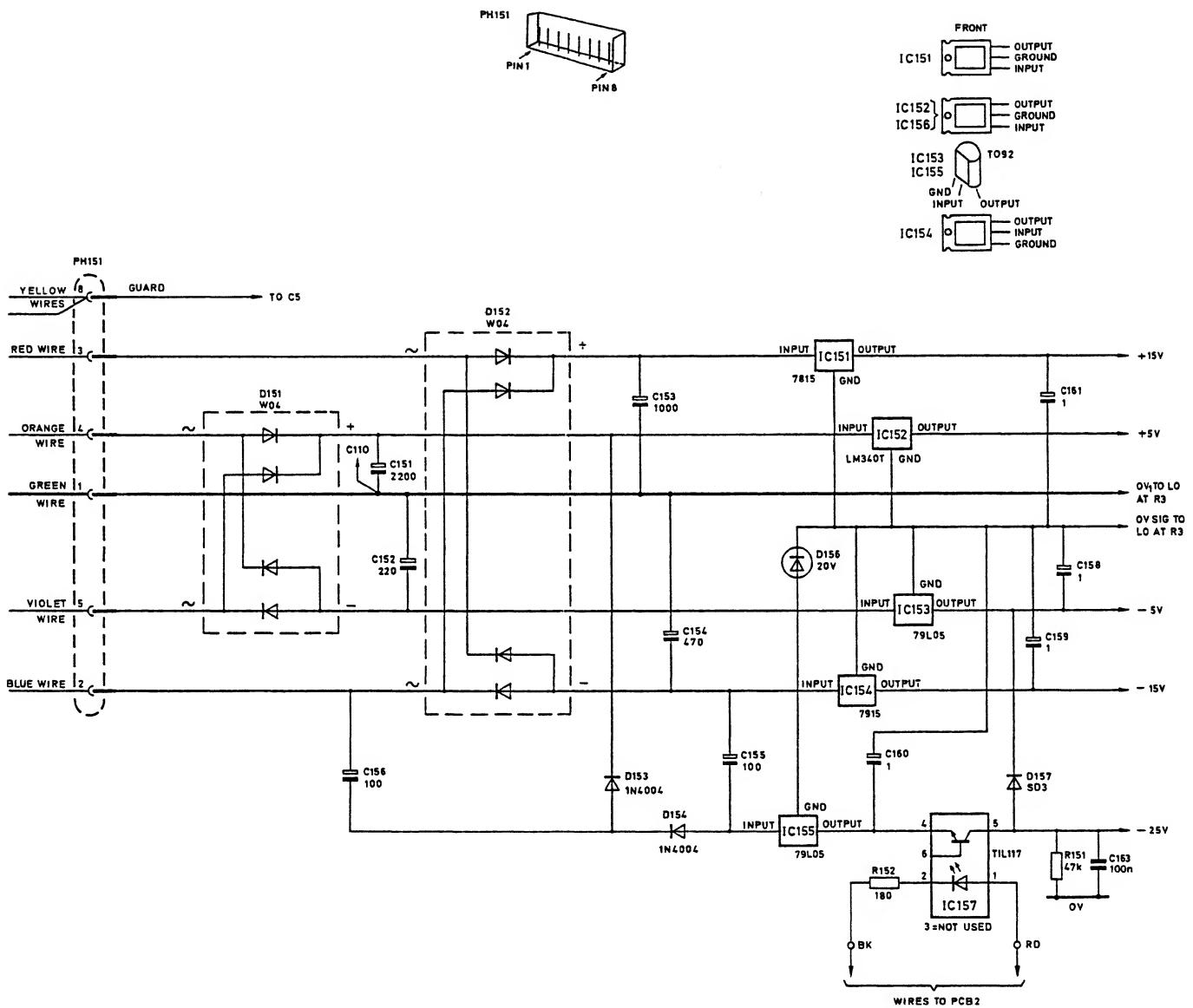


### Diag. 2.1 PCB 1, FLOATING ANALOG

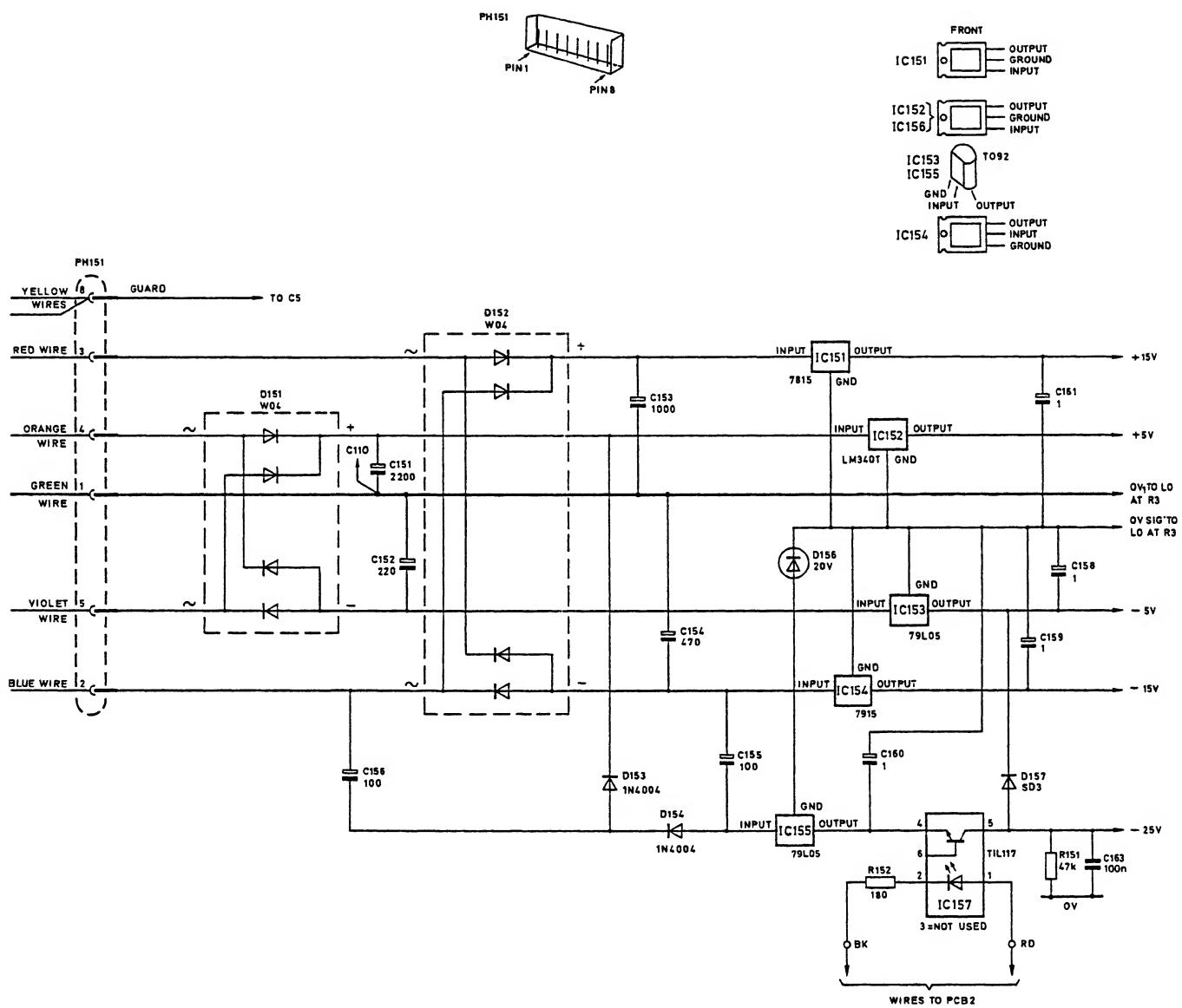
SPECIFICATION NO  
07.1517.501  
SHT 2 OF 3 SHS



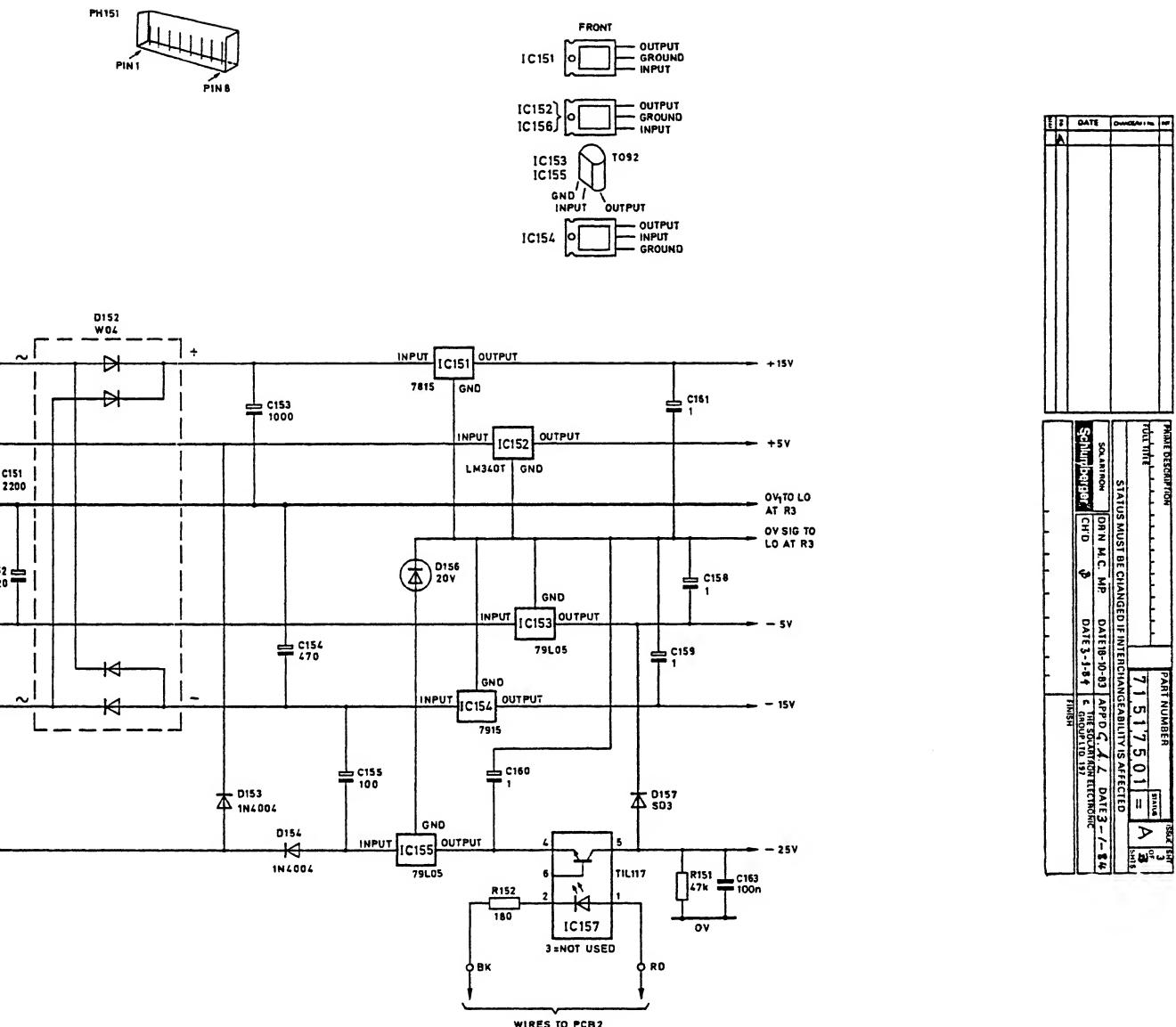




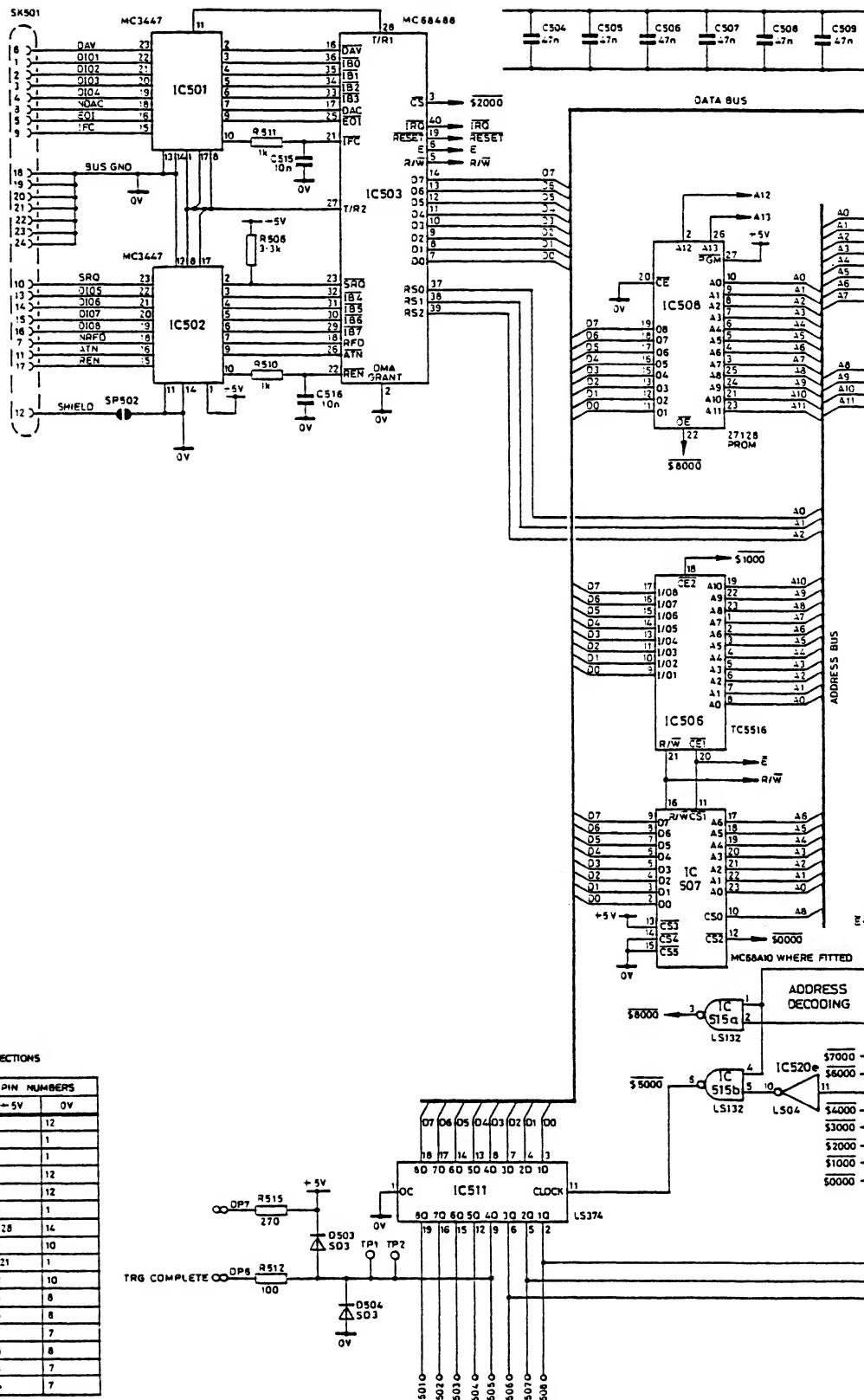
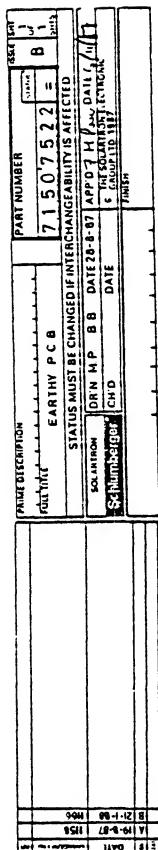
### Diag. 2.3 PCB 1, FLOATING ANALOG POWER SUPPLIES

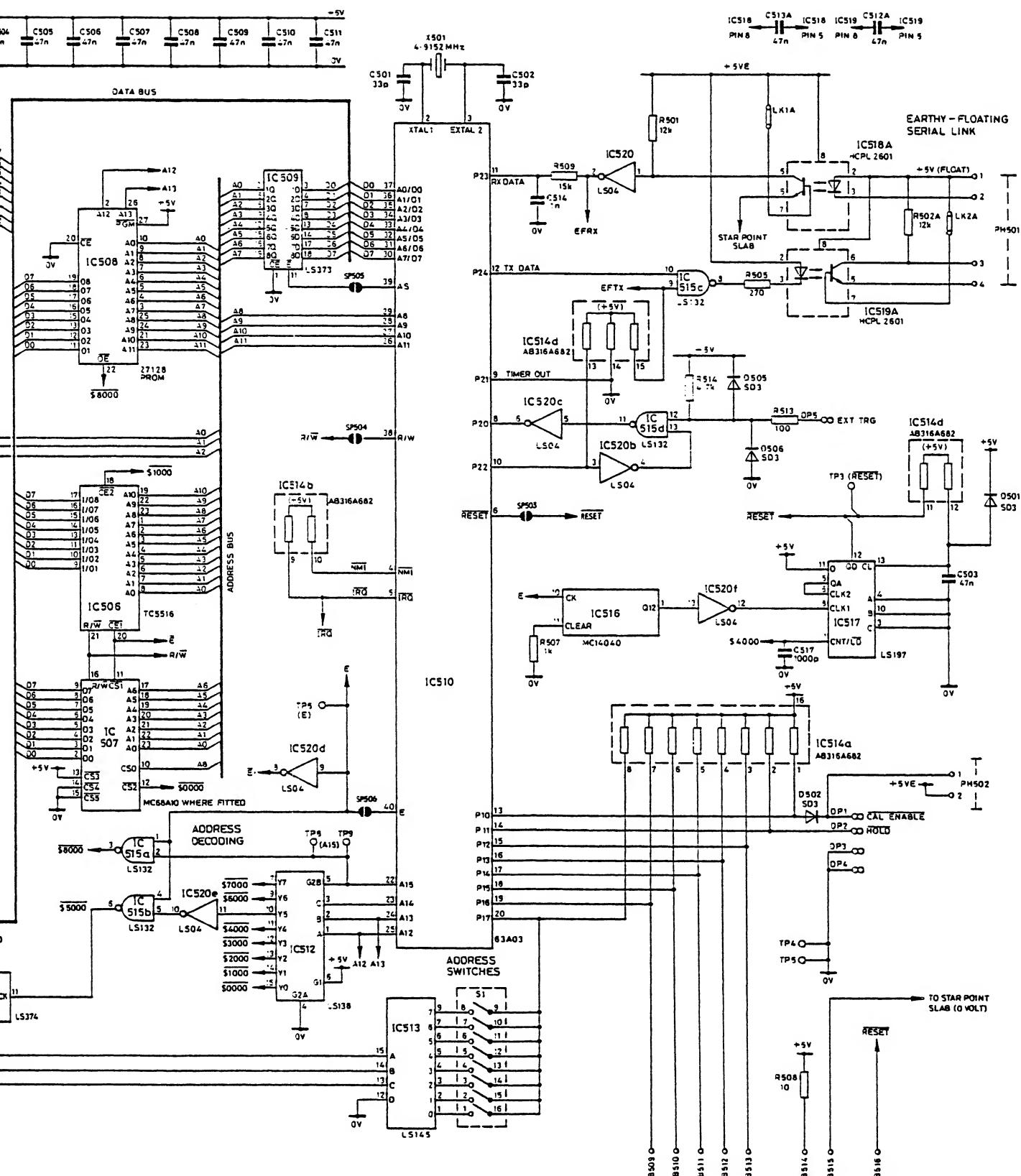


Diag. 2.3 PCB 1, FLO

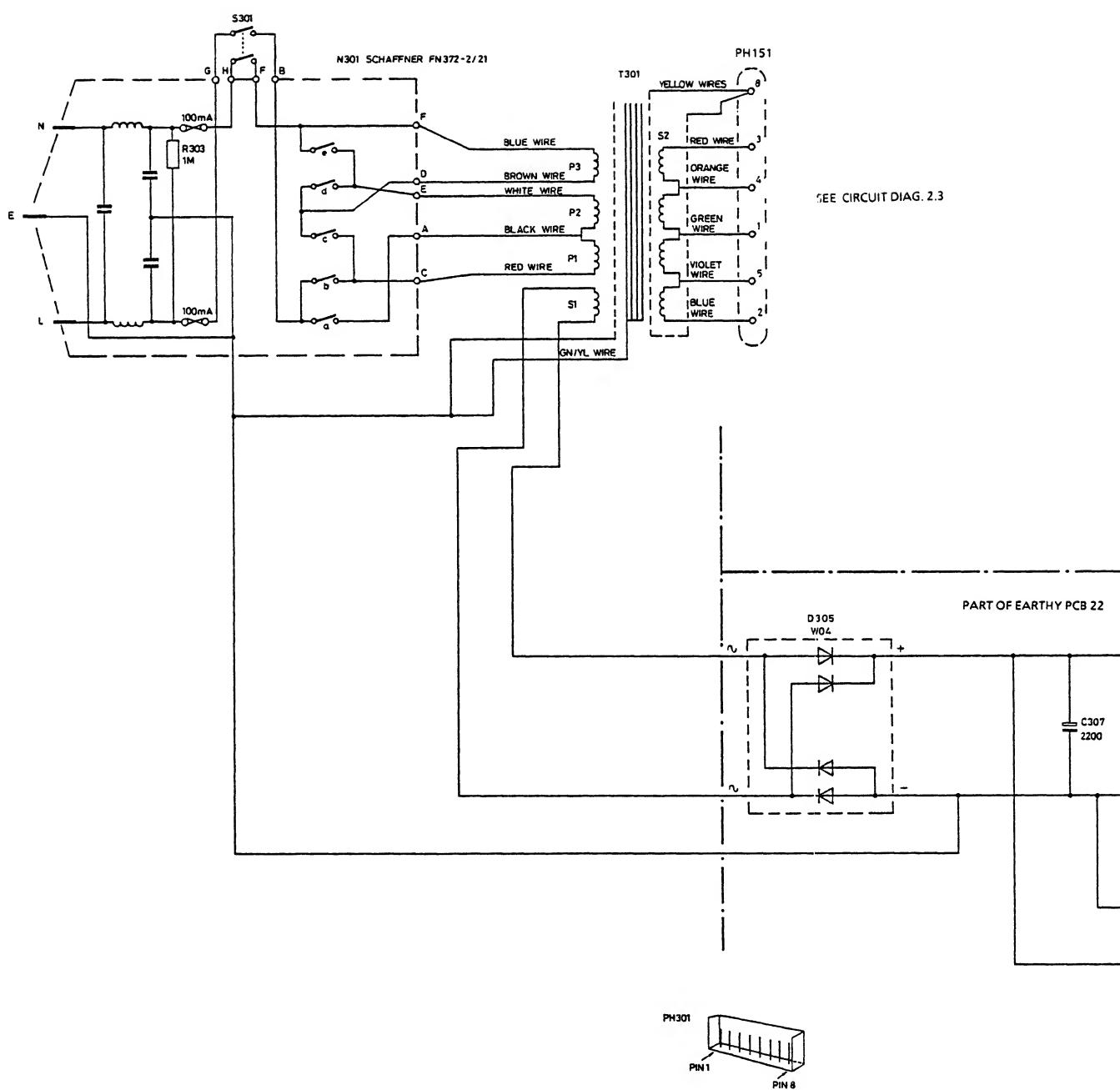


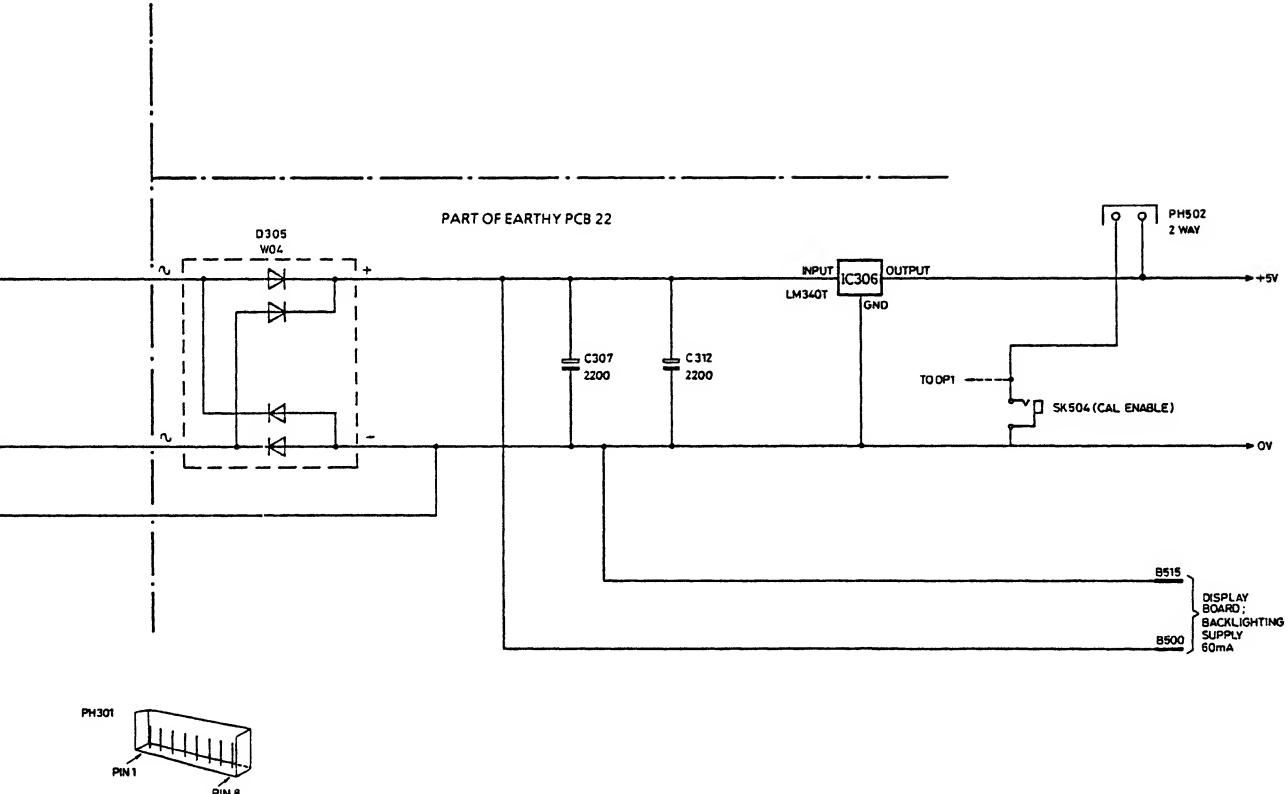
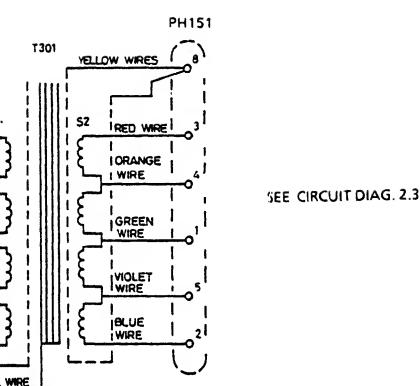
### Diag. 2.3 PCB 1, FLOATING ANALOG POWER SUPPLIES



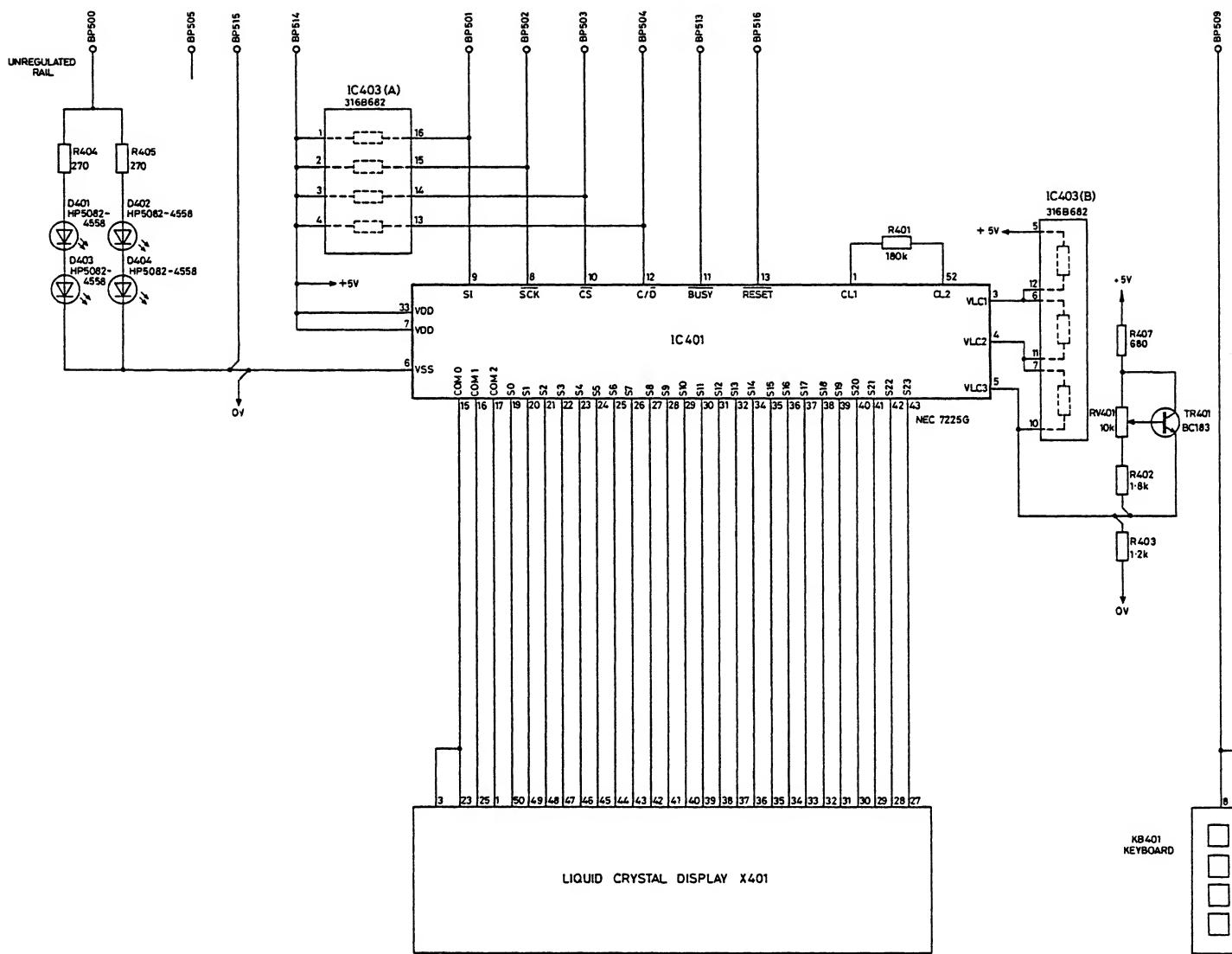


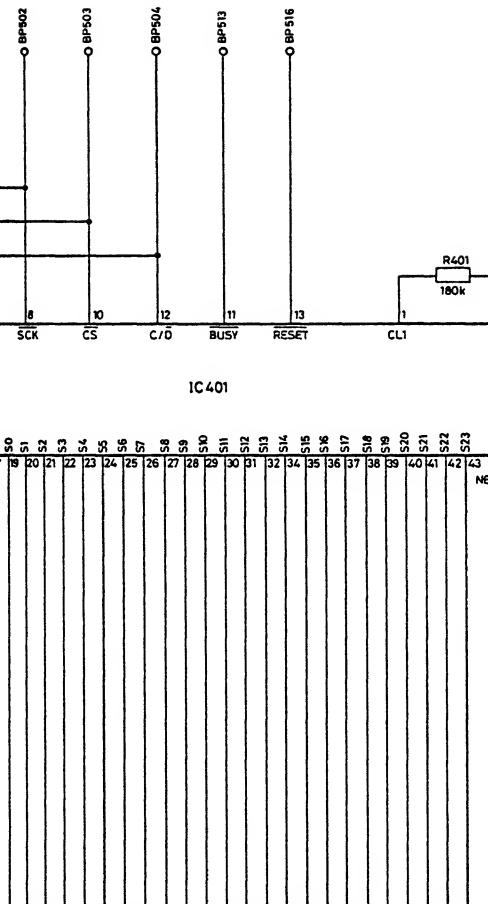
#### Diag. 2.4 *Pcb 22, EARTHY LOGIC*



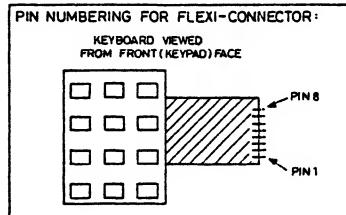
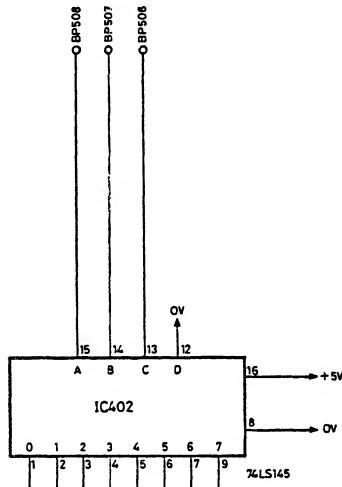
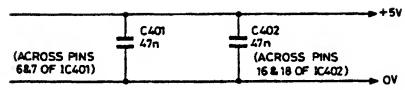
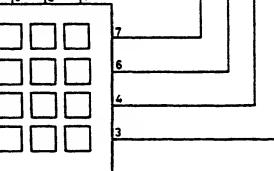
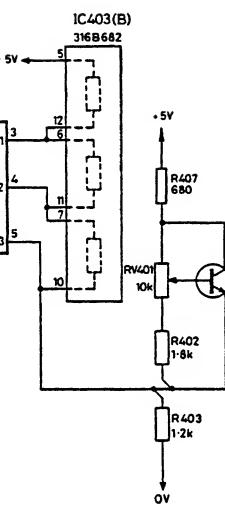


Diag. 2.5 EARTHY POWER SUPPLIES





LIQUID CRYSTAL DISPLAY X401





# Chapter 3

## Setting-up and Calibration Procedures

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*Cont.*

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## 1 GENERAL

These procedures enable the instrument to be set-up and calibrated to the factory despatch standards.

## 2 SAFETY

This instrument must be disconnected from the mains supply when partially dismantling it to gain access to the preset controls and also when it is being reassembled.

**When adjusting preset controls beware of high test voltages, the guard potential on the guard plate and also the mains input supply.**

## 3 DISASSEMBLY AND PRESET CONTROLS

To gain access to the preset controls refer to the disassembly instructions given in Chapter 4. The various preset controls are identified in Fig 3.1 on page 3.7.

## 4 EQUIPMENT REQUIREMENTS

The following equipment is required:

1. General purpose DMM, of at least 100000 scale length and:
  - a.  $\geq 10M\Omega$  i/p impedance on Vdc.
  - b.  $\geq 1M\Omega$  i/p impedance on Vac.
  - c.  $< 10$  ohm load on Idc and Iac.
2. General purpose oscilloscope.
3. Controller; Commodore PET fitted with BASIC 3 or BASIC 4 firmware.
4. Calibrator; Fluke 5100 or 5101 fitted with GP-IB Interface.
5. ACV Calibrator; Hewlett-Packard 745 (or equiv.)
6. ACV High Voltage Amplifier Hewlett-Packard 746 (or equiv.)
7.  $10 M\Omega$  resistor connected across a twin 4mm connector.
8. PET printer.
9. Software 71506598 and 71506599.
10. Schlumberger 7081 DVM. (Required for final and post calibration only).
11. Two screened input leads (to reduce series mode interference on high ohms).
12. 7150 test box for SK505 (test gear number 71506004).

## 5 GENERAL TESTS

General tests are carried out on the following:

Power supply  
Display  
Keyboard  
Rear panel

### 5.1 POWER SUPPLY TESTS

The mains selector should indicate 240 volts and the fusing should be 100mA SLO-BLO. Line voltage should be 240V.

Rail	Limits
15V unreg. floating.	+21V min. +27V max.
15V reg. floating.	+15V $\pm$ 0.75V.
-15V unreg. floating.	+22V min. +28V max.
-15 reg. floating.	+15V $\pm$ 0.75.
5V unreg. floating.	+9V min. +11.5V max.
5V reg. floating.	+5V $\pm$ 0.25V.
5V unreg. earthy.	+9V min. +11.5V max.
5V reg. earthy.	+5V $\pm$ 0.25V.

### 5.2 DISPLAY TESTS

The display contrast is adjusted using RV 401. The potentiometer should be adjusted to satisfy two criteria:

- The digits should appear as black as possible.
- The digits should appear to change quickly from one value to another.

It is possible, but incorrect, to satisfy criterion a. but have the numbers appear to slur from one value to another.

The display must be checked to confirm that all digits posses all their bars and decimal points; that all the top row annunciators are available; that all the mode annunciators (Vdc, Iac etc) are available.

### 5.3 KEYBOARD TESTS

Keyboard tests may be done manually or as part of a larger automated routine. The keys Vdc, Vac, kΩ/diode, Idc, Iac and °C/°F should be pressed and the display annunciators checked to confirm that the requested mode is shown.

The range keys should be pressed to confirm that ranging up/down operates satisfactorily and that AUTORANGE can be selected and deselected. The LOCAL key can only be checked when the DMM is already in REMOTE. Check that the REM annunciator goes out when LOCAL is pressed. The NULL key should be pressed and the display observed for nulling activity. The DIGITS key should be pressed to ensure that 4½, 5½ and 6½ digits (see Note) can be obtained. With 6½ digits selected, the FILT annunciator should flash.

Ensure that the 7150plus is left in the 5½ digits setting at the end of the keyboard tests.

Note. With 7150plus, a '½-digit' display window can display only the numbers 1 or 2. If the DMM is commanded remotely via the GP-IB Interface, then the figure 3 may also appear on a print-out.

### 5.4 REAR PANEL TESTS

Select a 5½ digit operation on the DMM using the front panel DIGITS button. Connect test box 71506004 to SK505 on the rear panel and check that the power LED in the test box illuminates. Then:

- a. Operate the HOLD switch and check that the HOLD annunciator appears on the DMM display.
- b. Press the EXTERNAL TRIGGER button on the test box and ensure that the HOLD annunciator on the DMM extinguishes for approximately 1 second and then re-appears with the display showing a new 'frozen' measurement result.
- c. Check also that the TRIGGER COMPLETE led on the test box flashes once for each press of the EXTERNAL TRIGGER button on the test box and that the COMP (measurement complete) annunciator on the front panel also flashes with each external trigger.

## 6 INITIAL SET-UP

The initial set-up procedures must be performed before any calibration of the DMM is attempted. During the procedure, ensure that the calibration jack plug is fitted only at the appropriate time.

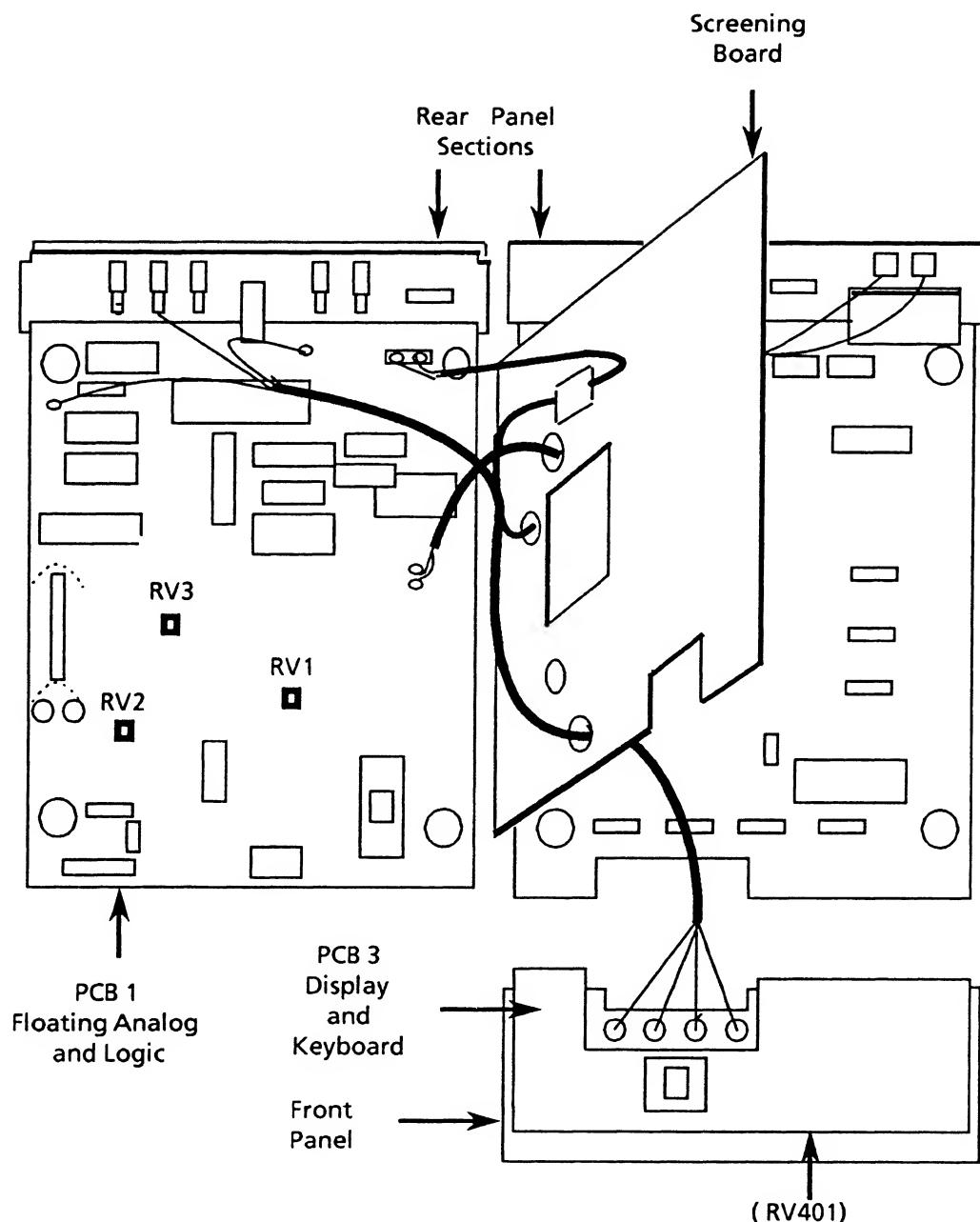
### 6.1 PRELIMINARIES

Fit the GP-IB adapter, then make the following switch settings on the DMM:

- a. Set the GP-IB ON/OFF switch to ON, set an appropriate address for the DMM and set both the TALK ONLY and LISTEN ONLY switches to OFF.
- b. Set front/rear switch to FRONT.
- c. Set the DMM power ON.

Insert the calibration jack-plug, then set-up the DMM using the following table and Fig 3.1. Once the steps in the table have been completed, proceed with the Initial Calibration.(Section 7).

Test	Range & Mode	Input	Action	Limits	Comment
1.	2Vdc	s/cV-Ω Hi/Lo	Adjust RV3 on 'DVM between LK2 & Rome DMM on HOLD	± 1mV	Input amp. gross offset null.
2.	2Vdc	s/cV-Ω Hi/Lo	Check display for scatter using ext. trigs with HOLD	3 adjacent values	2V Range noise test
3.	0.2Vdc	s/cV-Ω Hi/Lo	As above	4 adjacent values	0.2 Range noise test
4.	2Vdc	20Vdc V-Ω Hi/Lo	Measure across C4	between +3.90& +3.05	Positive input clamp test (D6)
5.	2Vdc	-20Vdc V-Ω Hi/Lo	As above	-3.90& -3.05	Negative input clamp test (D26)
6.	2Vdc	o/c V-Ω Hi/Lo	Adjust RV1, alternately measure each end of D20 (ref. Rome)	≤ 300µV difference (ignoring (polarity))	Cal. Bal. adjustment
7.	20Vac	s/cV-Ω Hi/Lo	Adjust RV2 for minimum dc voltage at TP3	≤ ± 50mV refered to 0V.	IC 15 offset null adjust. Use DMM to monitor TP3. Transformer laminations to be mains-grounded.



**Fig 3.1 Locations of Preset Controls**

## 7 INITIAL CALIBRATION

In the following sections, where the action is to perform a calibration of the DMM, the method using the front panel controls (as described in the Operating Manual) may be used. If these procedures are being performed with the use of software package 71506598/9 then calibration will be performed by the controller over the GP-IB bus and additional prompts will be displayed on the controller screen at the appropriate times.

Unless otherwise stated, use the Fluke 5101 Universal Calibrator.

### 7.1 DIRECT VOLTAGE

Test	Range & Mode	Input	Action	Limits	Comment
1.	2Vdc	+ 1.99999V & 0.00000V	Calibrate		Initial cal.
2.	0.2Vdc	+ 0.199999V & 0.000000V	Calibrate		Initial cal.
3.	20Vdc	+ 19.9999V & 0.0000V	Calibrate		Initial cal.
4.	200Vdc	+ 199.999V & 0.000V	Calibrate		Initial cal.
5.	1kVdc	+ 1000.00V & 0.00V	Calibrate		Initial cal. The calibrator Lo and the DMM Lo input should be mains grounded.

### 7.2 ALTERNATING VOLTAGE

Test	Range & Mode	Input	Action	Limits	Comment
1.	0.2Vac	0.199999V & 0.019999V 400Hz	Calibrate		Initial cal.
2.	2Vac	1.99999V & 0.19999V 400Hz	Calibrate		Initial cal.
3.	20Vac	19.9999V & 1.9999V 400Hz	Calibrate		Initial cal.

Test	Range & Mode	Input	Action	Limits	Comment
4.	200Vac	199.999V & 19.999V 400Hz	Calibrate		Initial cal.
5.	1kVac	750.00V & 199.99V 400Hz	Calibrate		Initial cal.

### 7.3 RESISTANCE

#### Notes:

1. Initial calibration requires only 2-terminal measurements.
2. On  $2M\Omega$  and  $20M\Omega$  ranges, a  $0.1\mu F$  polypropylene capacitor across the input terminals may help to reduce scatter.

Test	Range & Mode	Input	Action	Limits	Comment
1.	$2k\Omega$	1.00000k & $1\Omega$	Calibrate		Initial cal.
2.	$20k\Omega$	10.0000k & $1\Omega$	Calibrate		Initial cal.
3.	$200k\Omega$	100.000k & $1\Omega$	Calibrate		Initial cal.
4.	$2M\Omega$	1.00000M & $1\Omega$	Calibrate		Initial cal.
5.	$20M\Omega$	10.0000M & $1\Omega$	Calibrate		Initial cal.

### 7.4 DIRECT CURRENT

Test	Range & Mode	Input	Action	Limits	Comment
1.	Idc	+1.00000A & o/c.	Calibrate		Initial cal.

## 7.5 ALTERNATING CURRENT

Test	Range & Mode	Input	Action	Limits	Comment
1.	Iac	1.99999A & 0.19999A 400Hz	Calibrate		Initial cal.

## 7.6 END OF INITIAL CALIBRATION

If manual calibration has been carried out using the front panel, then exit cal. mode to return keyboard to normal operation.

Remove calibration jack-plug and record calibration temperature.

## 8. INITIAL CALIBRATION CHECKS

For the following checks, all displayed measurement results from the DMM are produced with HOLD off (continuous measurements).

### 8.1 DIRECT CURRENT

Test	Range & Mode	Input	Action	Limits	Comment
1.	Idc	1.99999A	Measure voltage across DMM input terminals	0.8V	Burden

### 8.2 RESISTANCE CHECKS

Test	Range & Mode	Input	Action	Limits	Comment
1.	20kΩ	o/c	Measure current from -I into Lo on rear i/ps (front/rear sw.set to REAR)	100±5μA	Refer to spec. of general purpose DMM(c.f. Sect. 2)
2.	200kΩ	o/c	As above	10.0± 0.5μA	As above

Test	Range & Mode	Input	Action	Limits	Comment
3.	$2M\Omega$	o/c	Measure current from -I into Lo on rear input terminals (front/rear sw. set to rear).	$1.0 \pm 0.05\mu A$	Refer to spec. of general purpose DMM (c.f. Sec. 2)
4.	$20k\Omega$	o/c	Measure the o/c volts at input terminals	$+5.2 \pm 1V$	Ohms source positive clamp
5.	$2M\Omega$	240Vac	Apply for 10 seconds		Ohms overload protection test
6.	$2M\Omega$	1.00000M $\Omega$		$1.00000M\Omega \pm 50$ bits	Survival check for damage from previous test

### 8.3 DIRECT VOLTAGE CHECKS

Test	Range & Mode	Input	Action	Limits	Comment
1.	0.2Vdc shunt V- $\Omega$ Hi/Lo	$10M\Omega$ (with HOLD off)	Check reading	$\pm 200mV$	Input current measurement
2.	2Vdc	+ 2.00000V -2.00000V	Measure. Re-adjust RV1 if necessary	$\pm 2$ bits pos-neg.	Linearity check. Change polarity by changing over the inputs
3.	2Vdc	+ 1.00000V -1.00000V	Measure pos-neg.	$\pm 2$ bits	Linearity check. Change polarity by changing over the inputs
4.	Vdc	+ 1000V and o/c	Connect Lo and GUARD of the DMM to LO of calibrator. Apply 1000V 5 times	$\pm 10$ bits	1kVstep input test. Ensure the DMM does reset and measures within limits
			Apply 1000V	$\pm 2$ bits	Drift over

for 1 minute.

this period  
should  
not exceed  
limits

#### 8.4 ALTERNATING VOLTAGE CHECKS

Test	Range & Mode	Input	Action	Limits	Comment
1.	20Vac 200Vac	19.999V 199.999V 400Hz	Note readings		Using HP 745/6 or equivalent
2.	200Vac 20V	199.999V 19.999V 100Hz	Adjust CV1 to minimise errors between the two ranges	Typically $\angle 300$ bits difference	Attenuator HF trim. Calibrator as above. Presence/absence of case lid does influence results
3.	0.2Vac	30kHz 0.199999V	Check	0.199999V $\pm 0.000120V$	
4.	0.2Vac	10kHz 0.199999V	Check	0.199999V $\pm 0.000096V$	
5.	2Vac	10kHz 1.99999V	Check	1.99999V $\pm 0.0096V$	
6.	2Vac	30kHz 1.99999V	Check	1.99999V $\pm 0.00120V$	
7.	20Vac	30kHz 19.9999V	Check	19.9999V $\pm 0.0120V$	
8.	20Vac	10kHz 19.9999V	Check	19.9999V $\pm 0.0096V$	
9.	200Vac	10kHz 199.999V	Check	199.999V $\pm 0.096V$	Using HP 745/6 or equivalent
10.	200Vac	30kHz 199.999V	Check	199.999V $\pm 0.120V$	As above
11.	1kVac	10kHz 750.00V	Check	750.00V $\pm 0.46V$	As above
12.	1kVac	30kHz 750.00V	Check	750.00V $\pm 0.70V$	As above

Test	Range & Mode	Input	Action	Limits	Comment
13.	0.2Vac	s/c	Check	$\leq 150\mu\text{V}$	S/c zero. Transformer laminations to be mains -grounded.
14.	2Vac	10Hz 2.00000V	Check	$2.00000\text{V}$ $\pm 0.01655\text{V}$	HP 745
15.	2Vac	20Hz 2.00000V	Check	$2.00000\text{V}$ $\pm 0.00416\text{V}$	HP 745
16.	2Vac	40Hz 2.00000V	Check	$2.00000\text{V}$ $\pm 0.00096\text{V}$	HP 745
17.	2Vac	100kHz 2.00000V	Check	$2.00000\text{V}$ $\pm 0.0880\text{V}$	HP 745
18.	0.2Vac	100kHz 0.19999V	Check	$0.199999\text{V}$ $\pm 0.00880\text{V}$	HP 745
19.	20Vac	100kHz 20.0000V	Check	$20.0000\text{V}$ $\pm 0.088\text{V}$	HP 745
20.	200Vac	100kHz 200.000V	Check	$200.000\text{V}$ $\pm 0.880\text{V}$	HP 745 + HP 746
21.	Vac Auto.	750V 400Hz	Lo and Guard of DMM to be connected to Lo of calibrator. Apply input 5 times ensuring proper down- range between each application.	750.00 V $\pm 0.46$	750 Vac autorange test

## 9 FINAL CALIBRATION

The DMM is calibrated in a fully cased condition using the equipment itemised in Section 4, items 10 and 11. It should be placed in a 20°C environment and switched on for at least 3 hours prior to calibration. Guard and Lo inputs should be mains grounded to minimise series-mode interference when calibrating the voltage modes.

The use of screened leads is essential for Hi ohms measurement. After the calibration sequence, a re-check is performed. Limits are given in the final table.

For Vdc re-checks only, the limits apply to the errors between the 7150plus reading and the 7081 reading of the same input.

The Fluke 5101B calibrator is to be characterised for calibration errors every three months. Errors from cardinal values are noted and are used as corrections within the software program.

### 9.1 DIRECT VOLTS

Test & Mode	Range	Input	Action
1.	0.2Vdc	+ 0.199999V & 0.000000V	Calibrate
2.	2Vdc	+ 1.99999V & 0.00000V	Calibrate
3.	20Vdc	+ 19.9999V & 0.0000V	Calibrate
4.	200Vdc	+ 199.999V & 0.000V	Calibrate
5.	1kVdc	+ 1000.00V & 0.00V	Calibrate

### 9.2 RESISTANCE

Make 4-terminal measurements using rear input terminals. The DMM I+ and I- should be connected to the Calibrator 'output' and the DMM Hi and Lo to the Calibrator 'sense'. Screened leads should be used.

Test	Range & Mode	Input	Action
1.	2kΩ	1kΩ & 1Ω	Calibrate
2.	20kΩ	10KΩ & 1 Ω	Calibrate

Test	Range & Mode	Input	Action
3.	200kΩ	100KΩ & 1 Ω	Calibrate
4.	2MΩ	1MΩ & 1 Ω	Calibrate
5.	20MΩ	10MΩ & 1 Ω	Calibrate

**9.3 ALTERNATING VOLTS**

All calibrations to be performed using frequencies between 400Hz and 1 kHz.

Test	Range & Mode	Input	Action
1.	0.2Vac	0.199999V & 0.019999V	Calibrate
2.	2Vac	1.99999V & 0.19999V	Calibrate
3.	20Vac	19.9999V & 1.9999V	Calibrate
4.	200Vac	199.999V & 19.999V	Calibrate
5.	1000Vac	750.00V & 150.00V	Calibrate

**9.4 DIRECT CURRENT**

Test	Range & Mode	Input	Action
1.	2A Idc	1.00000A & o/c	Calibrate

**9.4 ALTERNATING CURRENT**

All calibrations to be performed using frequencies between 400Hz and 1 kHz.

Test	Range & Mode	Input	Action
1.	2A Iac	1.99999A & 0.19999A	Calibrate

## 10. POST CALIBRATION CHECKS

Unless otherwise specified, all ac checks are to be performed using frequencies between 400Hz and 1kHz.

Test	Range & Mode	Input	Limits (bits)
1	20MΩ	10.0000MΩ	40
2	2MΩ	1.00000MΩ	7
3	200kΩ	100.000kΩ	5
4	20k	10.0000kΩ	5
5	2kΩ	1.00000kΩ	5
6	0.2Vac	0.199999V	70
7	2Vac	1.99999V	70
8	20Vac	19.9999V	80
9	200Vac	199.999V	80
10	1kVac	750.00V	45
11	0.2Vac	0.000000V	250
12	20Vac	19.9999V, 50kHz	300
13	0.2Vdc	0.199999V	6
14	2Vdc	1.99999V	6
15	20Vdc	19.9999V	6
16	200Vdc	199.999V	6
17	1kVdc	1000.00V	4
18	1kVdc	-1000.00	4
19	200Vdc	-199.999V	6
20	20Vdc	-19.9999V	6
21	2Vdc	-1.99999V	6
22	0.2Vdc	-0.199999V	6
23	2A Idc	+1.00000A	20
24	2A Iac	1.99999A	120

## 11 SAFETY CHECKS

Test	Range & Mode	Input	Action	Limits	Comments
1		1.5k max. Clare test gear	Do flash test		Safety test to IEC-348. Refer to Solartron Specification 09/00/105.02 Power sw. ON
2	Vdc Auto	See Fig. 1	Check display	$\pm 160\mu V$	Vdc common mode rejection 150dB. With $10k\Omega$
3	Vdc Auto	See Fig. 2	Check display	$0 \pm 34\mu V$	Vac common mode rejection 140dB. With $1k\Omega$
4	25 Amps 5 seconds		Perform continuity test	$0.5\Omega$	This test need not be done on all DMMs. Random sampling would suffice.
5			Fit mains fuses	250mA SLO-BLO for U.S. 100mA SLOBLO for U.K. and Europe	
6		1.5kV rms Clare test	Flash test Lo to ground		

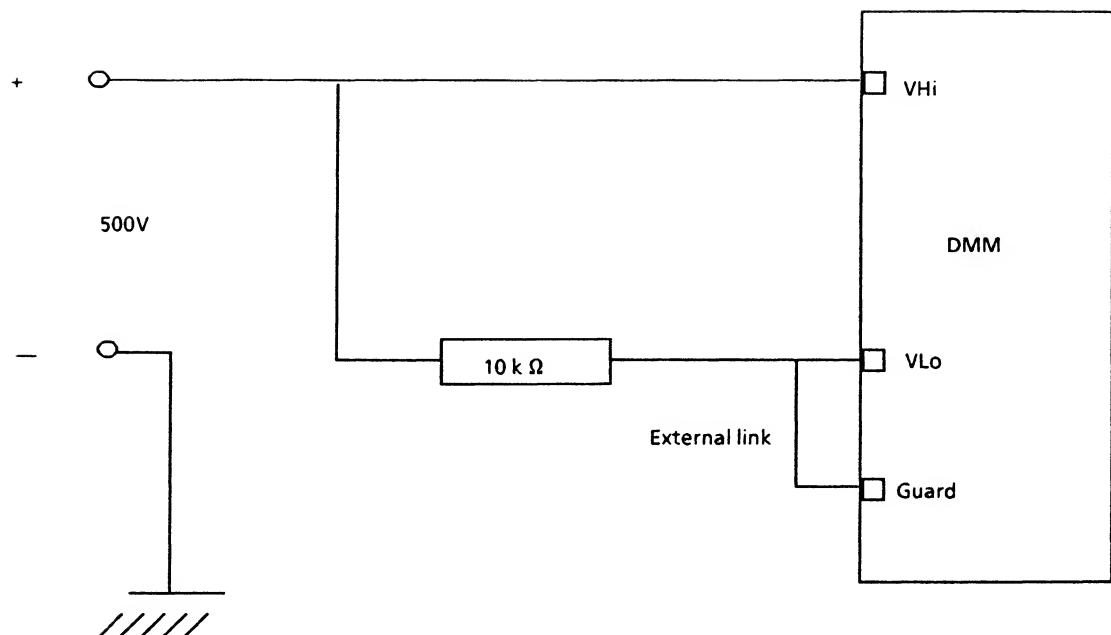


Fig. 1. Vdc Common Mode Rejection

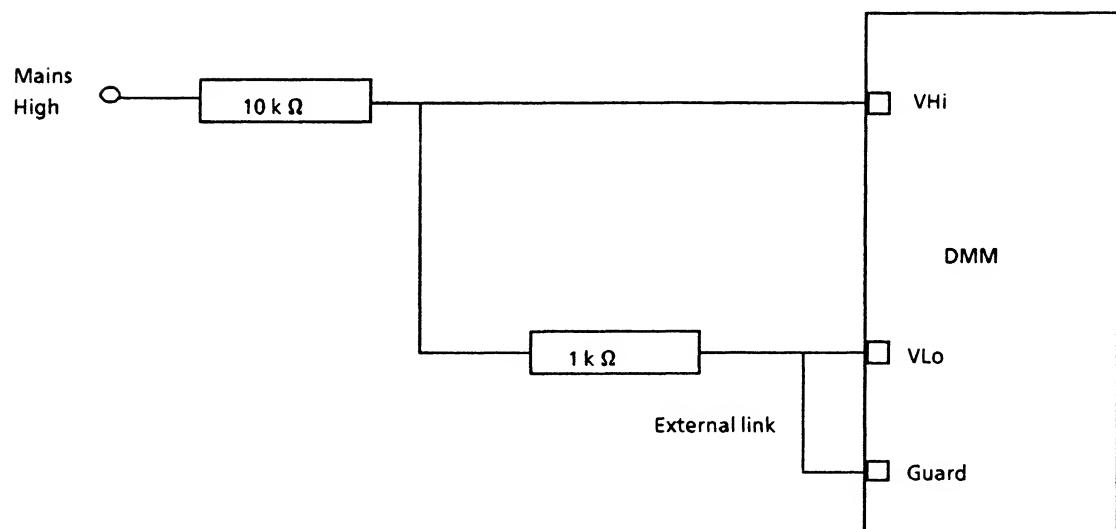


Fig. 2. Vac Common Mode Rejection

# Chapter 4

## Disassembly and Assembly Procedures

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<i>Section</i>	<i>Page</i>
1      Safety	4.3
2      Disassembly	4.3
3      Assembly	4.3

*Fig.*

4.1      7150plus Disassembled	4.5
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## 1 SAFTEY

**The 7150plus must be disconnected from the mains supply before proceeding with these instructions.**

## 2 DISASSEMBLY

1. Pivot the carrying handle to the rear of the case. Pull out the handle lugs from the pivot points on each side of the case and remove the handle.
2. Remove the four plastic caps and screws from the bottom of the case and then withdraw the top section of the case to expose the copper track side of pcb 1.
3. Compress the two plastic snap fasteners, located on the right hand side of pcb 1 (as viewed from the unit front) to release the pcb. Pivot the pcb outwards to gain access to the board components and to expose the screening pcb and the mains transformer.
4. Remove the two screws from the holes located in the mains transformer laminations and withdraw the complete instrument assembly from the bottom section of the case. Pcb 22 can now be accessed by unclipping the plastic stand-off fasteners which retain the screening board to the pcb.
5. At the left of the front panel assembly, remove the self-tapping screw which secures the front panel assembly to a clip on pcb 22. Unplug the front panel assembly from the pcb.
6. To gain access to pcb 3, remove the six screws which secure the pcb to the front panel. Note that pcb 3 remains attached to the front panel by the keyboard ribbon cable.

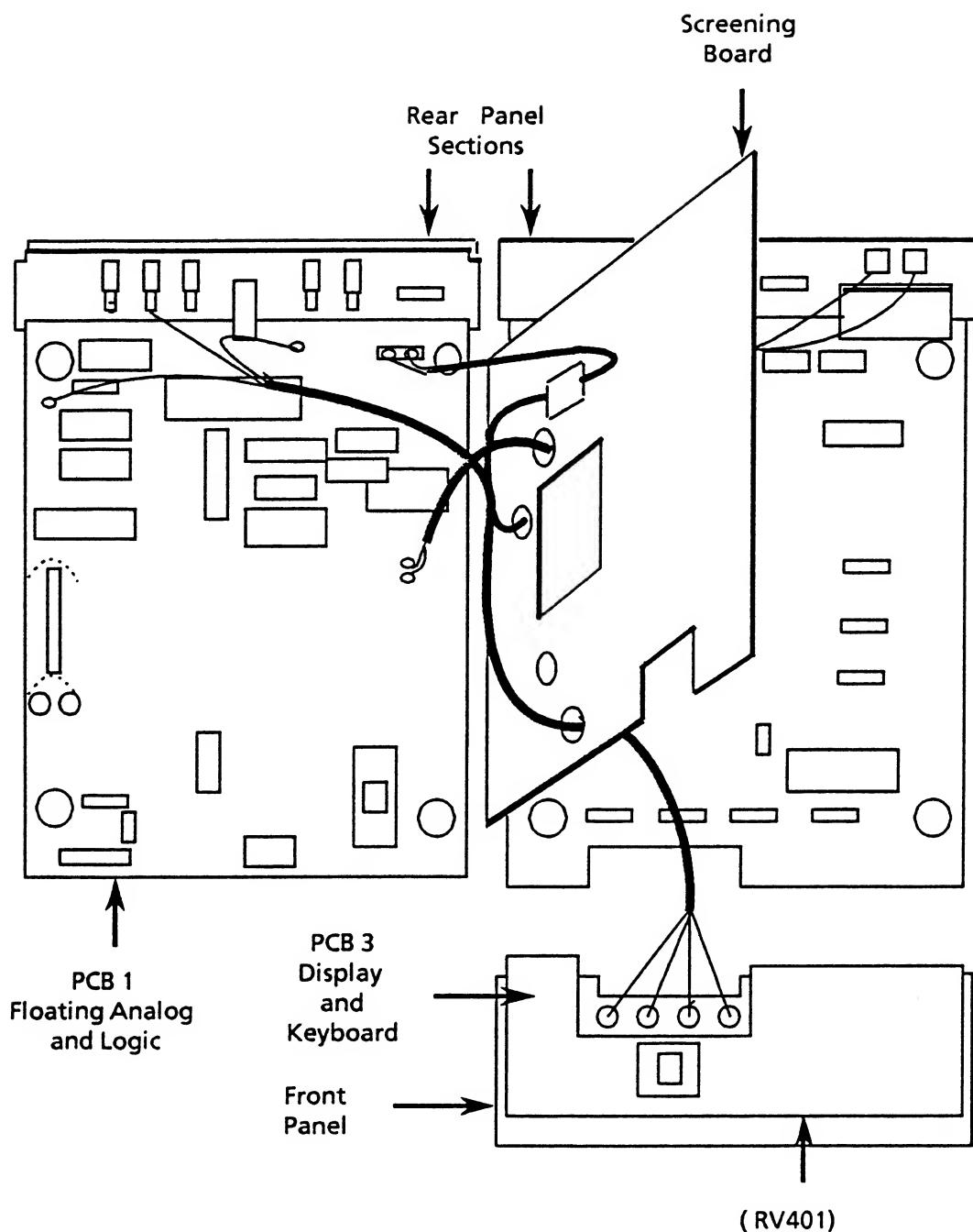
## 3 ASSEMBLY

1. Fit pcb 3 to the front assembly using the six screws (Sect 2, step 6).
2. Carefully plug the front panel assembly into pcb 22. Check that all of the connecting pins on the front panel assembly are correctly inserted into the socket pins on pcb 22.
3. Fit the self-tapping screw which secures the front panel assembly to pcb 22.
4. Attach the screening board to pcb 22 by using the plastic stand-off fasteners.
5. Insert the complete instrument assembly into the bottom section of the case. Insert the two screws into the holes on the mains transformer laminations and tighten to secure the bottom section of the case.
6. Secure pcb 1 by use of the two plastic snap fasteners located on the right hand side of the pcb.
7. Dress the cables on the top of the screening board clear of the holes in the board which locate the extended lugs in the top section of the case.

8. Insert the top section of the case onto the instrument assembly and secure the top section to the bottom section by the four screws inserted into the bottom section of the case.

**Note:** It is important that these four screws are fully tightened otherwise the case screening is made ineffective and consequently, the ac calibration could be impaired.

9. Fit the handle by lining up the locating lugs on the handle with the pivot points on each side of the case and then press the handle lugs into the pivoting points on the case.



**Fig. 4.1 7150plus Disassembled**



# Chapter 5

## Parts Lists and Layout Diagrams

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<i>Section</i>	<i>Page</i>
1 <b>Introduction</b>	5.3
2 <b>PCB 1 (71500501) Floating Analog and Logic</b>	5.5
3 <b>PCB 22 (71500522) Earthy Logic</b>	5.11
4 <b>PCB 3 (71500503) Display and Keyboard</b>	5.13
5 <b>Front Panel Assembly</b>	5.13
6 <b>Rear Panel Assembly</b>	5.14
7 <b>Power Supplies</b>	5.14

*Fig.*

1 <b>PCB 1 Component Location</b>	5.15
2 <b>PCB 22 Component Location</b>	5.17
3 <b>PCB 3 Component Location</b>	5.19



## 1 INTRODUCTION

This section contains component layout diagrams and detailed parts lists for each of the three printed circuit boards and the front and rear panels. When ordering spare parts, it is essential to quote the instrument serial number located on the rear panel as well as the full description of the item given in the appropriate parts list.

A description of the abbreviations used in the parts list is given overleaf.

## COMPONENT PARTS LIST ABBREVIATIONS

### CIRCUIT REFERENCES

AE Aerial  
 B Battery  
 C Capacitor ( $\mu\text{F}$ )  
 CSR Controlled Silicon Rectifier (thyristor)  
 CV Capacitor, Variable ( $\mu\text{F}$ )  
 D Diode  
 FS Fuse  
 HS Heatsink  
 IC Integrated Circuit  
 JP Jumper  
 L Inductor  
 LK Link  
 ME Meter  
 MSP Mains Selector Panel

PL PLug  
 R Resistor ( $\Omega$ )  
 RE Recording Instrument  
 RL Relay  
 RNL Resistor, Non-linear ( $\Omega$ )  
 RP Resistor Pack ( $\Omega$ )  
 RV Resistor, Variable ( $\Omega$ )  
 S Switch  
 SK Socket  
 T Transformer  
 TP Test Point (or Terminal Post)  
 TR Transistor  
 V Valve  
 ZD Zener Diode

### COMPONENT TYPES

#### Fixed Resistors

CACP Carbon Composition  
 CAFM Carbon Film  
 CKCA Cracked Carbon  
 MEFM Metal Film  
 MEGL Metal Glaze  
 MEOX Metal Oxide  
 POWW Power, Wirewound  
 PRWW Precision, Wirewound  
 TEMP Temperature Sensitive  
 TKFM Thick Film  
 TNFM Thin Film  
 VOLT Voltage Sensitive

#### Variable Resistors

CAFM Carbon, Front Panel, Multiturn  
 CAFS Carbon, Front Panel, Single Turn  
 CAPM Carbon, Preset, Multiturn  
 CAPS Carbon, Preset, Single Turn  
 CMFM Cermet, Front Panel, Multiturn  
 CMFS Cermet, Front Panel, Single Turn  
 CMPM Cermet, Preset, Multiturn  
 CMPS Cermet, Preset, Single Turn  
 WWFM Wirewound, Front Panel, Multiturn  
 WWFS Wirewound, Front Panel, Single Turn  
 WWPM Wirewound, Preset, Multiturn  
 WWPS Wirewound, Preset, Single Turn

#### Capacitors

AIR Air  
 ALME Aluminium Electrolytic  
 ALMS Aluminium Solid  
 CARB Polycarbonate  
 CERM Ceramic  
 ESTF Polyester Foil  
 ESTM Polyester, Metallised  
 GLAS Glass  
 MICA Mica

MLAC Metallised Lacquer  
 PAPF Paper Foil  
 PAPM Paper Metallised  
 PTFE Polytetrafluoroethylene  
 PYLN Polypropylene Film  
 STYR Polystyrene  
 TAND Tantalum, Dry  
 TANF Tantalum Foil  
 TANW Tantalum, Wet

## PCB 1 (71510501) FLOATING ANALOG AND LOGIC

Cct Ref.	General Description				Schlumberger Part No.
R1	TKFM	CAD 1776			
R2	MEOX	1k	0.25W	5%	195631000
R3	PRWW	0.1		0.5%	160300506
R4	MEGL	22k	3W	5%	176442200
R5	CACP	10k	0.5W	10%	172341000
R6	MEFM	1.2k	0.125W	0.5%	192731202
R7	MEFM	30.9k	0.125W	0.25%	192843094
R8	MEOX	100k	0.25W	5%	195651000
R9	MEGL	47k	3W	2%	175244700
R10	MEFM	990k	2W	0.5%	160400487
R11	TKFM	1k + 9k	0.2W	0.1%	160400582
R12	MEOX	3.3k	0.25W	5%	195633300
R13	MEOX	1k	0.25W	5%	195631000
R14	-	1452	matched		
R15	-	9k	pair.	0.25%	169617201
R16	TKFM	CAD1776k			160400583
R17	MEFM	10k	0.125W	0.5%	192741002
R18	-	9k	matched		
R19	-	1k	pair	0.25%	169617001
R21	TKFM	1k + 9k	0.2W	0.1%	160400582
R20	-	100k	matched .		169617101
R24	-	67k	pair		
R22	MEOX	33k	.25W	5%	195643300
R23	MEFM	30k	0.125W	0.5%	192743002
R25	MEGL	47k	3W	2%	175244700
R26	MEOX	33k	0.25W	5%	195643300
R27	MEFM	280k	0.125W	0.25%	192852804
R28	MEOX	1k	0.25W	5%	195631000
R29	MEOX	100	0.25W	5%	195621000
R30	MEOX	100k	0.25W	5%	195651000
R31	MEOX	100k	0.25W	5%	195651000
R32	MEOX	22k	0.25W	5%	195642200
R33	MEOX	1k	0.25W	5%	195631000
R34	MEOX	100	0.25W	5%	195621000
R35	MEOX	4.7k	0.25W	5%	195634700
R36	MEOX	4.7k	0.25W	5%	195634700
R37	CACP	470k	0.5W	10%	172354700
R38	MEFM	10k	0.125W	0.5%	192741002

## PCB1 (CONTINUED)

Cct Ref.	General Description				Schlumberger Part No.
R39 to R41	MEOX	33k	0.25W	5%	195643300
R42	MEFM	100	0.125W	0.5%	192721002
R43	MEOX	4.7k	3W	5%	193734700
R44	CACP	470k	0.5W	10%	172354700
R45	MEOX	100k	0.25W	5%	195651000
R46	MEOX	1k	0.25W	5%	195631000
R47	MEOX	1M	0.5W	5%	193561000
R48	MEOX	100k	0.25W	5%	195651000
R49	MEFM	200k	0.125W	0.5%	192752002
R50	MEFM	1M	0.25W	0.5%	198261002
R51	MEFM	62k	0.125W	0.5%	192746202
R52	MEOX	33k	0.25W	5%	195643300
R53	MEOX	1k	0.25W	5%	195631000
R54	MEOX	56	0.25W	5%	195615600
R55	CACP	10k	0.5W	10%	172341000
R56	CACP	2.7M	0.125W	10%	172062700
R57	MEFM	10k	0.125W	0.5%	192741004
R59	MEFM	27k	0.125W	0.5%	192742702
R61	MEOX	180	0.25W	5%	195621800
R62	MEOX	180	0.25W	5%	195621800
R63	MEOX	10k	0.25W	5%	195641000
R64	MEOX	22k	0.25W	5%	195642200
R65	MEOX	22k	0.25W	5%	195642200
R66	MEOX	82k	0.25W	5%	195648200
R67	MEFM	22k	0.125W	0.5%	192742202
R68	MEFM	22k	0.125W	0.5%	192742202
R69	MEOX	1k	0.25W	5%	195631000
R70	MEFM	4.7k	0.125W	0.5%	192734702
R71	MEFM	15k	0.125W	0.5%	192741502
R72	MEOX	1M	0.5W	5%	193561000
R73	PRWW	10k	0.2W	0.25%	160300505
R74	PRWW	90k	0.2W	0.01%	160300438
R75	PRWW	900k	0.3W	0.25%	160300504
R76 to R79	CACP	1M	0.25W	10%	172061000
R80	MEOX	100	0.25W	5%	195621000
R81	MEOX	100	0.25W	5%	195621000
R82	MEFM 33	0.125W		0.5%	192713302

## PCB1 (CONTINUED)

Cct Ref.	General Description					Schlumberger Part No.
R101	MEOX	15k	0.25W	5%		195641500
R103	MEOX	270	0.25W	5%		195622700
R104	MEOX	1.5k	0.25W	5%		195631500
R105	MEOX	100	0.5W	1%		195421000
R106	MEOX	100	0.25W	5%		195621000
R151	MEOX	47k	0.25W	5%		195644700
R152	MEOX	180	0.25W	5%		195621800
RV1	CMPM	200	0.5W	10%		130922000
RV2	CMPM	200k	0.5W	10%		110016220
RV3	CMPM	2k	0.5W	10%		130932000
C1	CERM	200p	500V	20%		241322200
C2	ESTM	0.22	400V	20%		226152200
C3	ESTF	0.01	1000V	10%		222841000
C4		470p				208100201
C5	ESTF	22n	400V	10%		222342200
C6	ESTM	15n	100V	10%		225441500
C7	ESTM	0.47	100V	10%		225454700
C8	ESTM	0.22	100V	10%		225452200
C9	ESTF	15n	400V	10%		222341500
C10	CERM	47n	25V	25%		241944700
C11	CERM	47n	25V	25%		241944700
C12	CARB	100p	160V	20%		208900004
C13 to C15	CERM	47n	25V	25%		241944700
C16	ESTM	1	100V	10%		225461000
C17	ESTM	2.2	100V	10%		225462200
C18 to C21	CERM	47n	25V	25%		241944700
C22	TAND	10	25V	20%		208700108
C23	TAND	10	25V	20%		208700108
C24	CERM	6.8p	500V	20%		241306800
C25	CERM	47n	25V	25%		241944700
C26	CERM	47p	500V	20%		241314700
C27	CERM	150p	500	20%		241321500
C28	CERM	47p	500V	20%		241314700
C29	ESTM	4.7	63V	10%		225164700
C30	CERM	47n	25V	25%		241944700
C31	CERM	47n	25V	25V		241944700

## PCB1 (CONTINUED)

Cct Ref.	General Description				Schlumberger Part No.
C32 to C35	CERM	10n	25V	25%	241941000
C36 to C39	CERM	220p	500V	20%	241322200
C40	CERM	10n	25V	25%	241941000
C41	CERM	47n	25V	25%	241944700
C42		33n			208100207
C101	CERM	33p	500V	20%	241313300
C102	CERM	33p	500V	20%	241313300
C103	TAND	22	16V	20%	208700106
C104 to C108	CERM	47n	25V	25%	241944700
C109	CERM	47n	25V	25%	241944700
C110	CERM	47n	25V	25%	241944700
C111	CERM	47n	25V	25%	241944700
C112	CERM	100p	500V	20%	241321000
C151	ALME	2200	16V		273392200
C152	ALME	200	16V		273382200
C153	ALME	1000	40V		273791000
C154	ALME	470	40V		273784700
C155	ALME	100	25V		273581000
C156	ALME	100	25V		273581000
C158 to C161	TAND	1	35V	20%	266061000
C163	CERM Multi-layer	100n	50V	20%	208450140
CV1	PTFE	2-14p			290060030
D1	SD3				300522160
D2	WR057				300525770
D3	SD3				300522160
D4	BZY88 Zen. 400mW	5.6V			300521450
D5	BZY88 Zen. 400mW	8.2V			300521330
D6	WR057				300525770
D7	IN4577				300525050
D8 to D15	SD3				300522160

## PCB1 (CONTINUED)

Cct Ref.	General Description			Schlumberger Part No.
D16	IN3595			300523590
D17	IN3595			300523590
D18	SD3			300522160
D19	SD3			300522160
D20	IN829A Zen. 400mW	6.2V Ref.		300525400
D21	SD3			300522160
D22	SD3			300522160
D25	WR057			300525770
D26	WR057			300525770
D27	BZY88 Zen.	400mW	20V	300523790
D28	SD3			300522160
D101	SD3			300522160
D151	W04	400V		300524700
D152	W04	400V		300524700
D153	IN4004			300522070
D154	IN4004			300522070
D156	BZY88 Zen.	400mW	5%	300523790
D157	SD3			300522160
TR1	3N163			300554530
TR2	3N163			300554530
TR3	3N163			300554530
TR4				300555770
to	WN1001			
TR6				
TR7	PN4118A			300555880
TR8	WN1001			300555770
TR9	WN1001			300555770
TR10	U1897			300553800
TR11	BCY70			300553590
TR12	WN1001			300555770
TR13	WD460			300555820
TR14	BC183			300555590
TR101	BC183			300555590
IC1	OP14	Op. Amp.( matched with IC6)		510091360
IC2	DG211	Quad. Analog SPST switch		510091180
IC3	AD545K	Precision FET Op. Amp.		510090741
IC4	OP05	Op.Amp.		510091130

## PCB1 (CONTINUED)

Cct Ref.	General Description		Schlumberger Part No.
IC5	DG211	Quad. Analog SPST switch	510091180
IC6	OP-14	Op. Amp.( matched with IC1)	510091360
IC7	DG211	Quad. Analog SPST switch	510091180
IC8	OPO5	Op. Amp.	510091130
IC9	LM311	Voltage Comparator	510091280
IC10	LM311	Voltage Comparator	510091280
IC11	74LS175		510003170
IC12	LM339	Quad O/Collector Comparator	510090490
IC13	ULN2003		510004980
IC14	LM339	Quad O/Collector Comparator	510090490
IC15	AD528J	FET Op. Amp.	510090380
IC16	DG200	Dual Analog Switch	510091170
IC17	74LS00	Quad Dual i/p Nand Gate	510002000
IC18	DG211	Quad. Analog SPST switch	510091180
IC21	AD637K	RMS-to-DC Converter	510091460
IC102	74LS04	Hex. Inverters	510002690
IC103	HD68P01V05P	Microprocessor	510006250
IC104		Resistor Pack 6.8k	160400569
IC105	NC7033		510005150
IC106	NC7033		510005150
IC107	4040BE	12-Stage Ripple Counter	510001820
IC108	74LS197	4-Bit Binary Counter	510005750
IC151	7815 CKC	15V 0.5A pos. Voltage Reg.	510090320
IC152	LM340T5	5V 0.5A pos. Voltage Reg.	510090500
IC153	79L05ACZ	5V 0.1A neg. Voltage Reg.	510090950
IC154	7915	15A neg. Voltage Reg.	510090330
IC155	19L05ACZ	5V 0.1A neg. Voltage Reg.	510090950
IC157	TIL 117	Opto Transistor	300540240
PH151		Header 8- way 0.1" Pitch	352308060
SG1		Ceramic Surge Voltage Protector 1400V	300011470
FH		Fuse Holder	360206040
F1		Fuse 2A 5mm x 20mm	360106150
RLA	Coto 4000-0002		301203400
RLB	Coto 7002-5005		301203300
RLC	Coto 7002-5085		301203500
RLD	Coto 7002-5086		301203600
RLE	Coto 4000-0002		301203400
RLF	RS12		300652190
RLK	Coto 7002-5085		301203500

## PCB1 (CONTINUED)

Cct Ref.	General Description	Schlumberger Part No.
X101	4.9152MHz Crystal, 30pF 0.01%	300810590
TP1 to TP4	Test Hook	355400760

## 3. PCB 22 (71500522) EARTHY LOGIC

Cct Ref.	General Description	Schlumberger Part No.
R501A	MEOX 12k 0.25W 5%	195641200
R502A	MEOX 12k 0.25W 5%	195641200
R505A	MEOX 270 0.25W 5%	195622700
R506	MEOX 3.3k 0.25W 5%	195633300
R507	MEOX 1k 0.25W 5%	195631000
R508	CACP 10 0.125W 10%	172011000
R509	MEOX 15k 0.25W 5%	195641500
R510	MEOX 1k 0.25W 5%	195631000
R511	MEOX 1k 0.25W 5%	195631000
R512	GPMF 100 0.25W	195321000
R513	GPMF 100 0.25W	195321000
R514	GPMF 4.7k 0.25	195334700
R515	GPMF 270 0.25	195622700
C307	ALME 2200 16V	273392200
C312	ALME 2200 16V	273392200
C501	CERM 33p 500V 20%	241313300
C502	CERM 33p 500V 20%	241313300
C503	CERM 47n 25V +50% -25%	241944700
C504 to C511	CERM 47n 25V +50% -25%	241944700
C512A	CERM 47n 25V +50% -25%	241944700
C513A	CERM 47n 25V +50% -25%	241944700
C514	CERM 1n 500V 20%	241331000
C515	CERM 10n 25V +50% -20%	241941000
C516	CERM 10n 25V +50% -25%	241941000
C517	CERM 1n 500V 20%	241331000

## PCB 22. (CONTINUED)

Cct Ref.	General Description			Schlumberger Part No
D305	W04	400V		300524700
D501	SD3			300522160
D502	SD3			300522160
D503 to D506	SD3	0.075A	75V	300522160
IC306	LM340T5			510090500
IC501	MC3447			510005700
IC502	MC3447			510005700
IC503	MC68488			510004291
IC506	TC5516			510005470
IC508	27128-30			510006271
IC509	LS373			510004870
IC510	HD6303P			510006170
IC511	LS374			510004390
IC512	LS138			510003530
IC513	LS145			510004990
IC514	AB316A682			160400569
IC515	LS132			510002980
IC516	MC14040			510001820
IC517	LS197			510005750
IC518A	HCPL 2601			300540260
IC519A	HCPL 2601			300540260
IC520	LS04			510002690
S1	Switch			375000600
SK501	GPIB socket			352524320
PH501A	4 - Way Header post			352304080
PH502	2 - Way Header post			352302080
T301	Transformer			309617106
IC503	Socket, 40-pin DIL			300585190
IC508	Socket, 28-pin DIL			300585160
IC510	Socket			300585190
TP 1 to TP6	Test Hook			355400760
TP8	Test Hook			355400760
TP9	Test Hook			355400760

**PCB 22. (CONTINUED)**

Cct Ref.	General Description				Schlumberger Part No.
LK1A	TCW, 22 SWG				480080080
X501	4.9152 MHz Crystal				300810590

**4. PCB 3 (71500503) DISPLAY AND KEYBOARD**

Cct Ref.	General Description				Schlumberger Part No.
R401	MEOX	180k	0.25W	5%	195651800
R402	MEOX	1.8k	0.25W	5%	195631800
R403	MEOX	1.2k	0.25W	5%	195631200
R404	MEOX	270	0.25W	5%	195622700
R405	MEOX	270	0.25W	5%	195622700
RV401	CMPM	10k	0.5W	10%	130641000
C401	CERM	47n	25V	+ 50% - 25%	241944700
C402	CERM	47n	25V	+ 50% - 25%	241944700
D401 to D404	LED HP5082 - 4558				300750270
TR401	BC183				300555590
IC401	NEC 7225G				510005890
IC402	74LS145				510004990
IC403	316B 6.8k				192136800
SK402	25-way				352525090
SK403	25-way				352525090
KB401	Keyboard Matrix				71502019A
X401	Liquid Crystal Display				71502006A

**5. FRONT PANEL ASSEMBLY**

Cct Ref.	General Description				Schlumberger Part No.
Socket	Red, 4mm				352501470
Socket	Black, 4mm				352501480
Socket	Brown, 4mm				352501750
Socket	Green, 4mm				352501490

## 6. REAR PANEL ASSEMBLY

Cct	General Description			Schlumberger
Ref.				Part No.
R303	Resistor 1MΩ			172361000
FH1	Fuse Fast Blow	2A		360106150
	Fuse Slow Blow	100mA		360106260
S301	Mains switch			375500030
	Socket Jack			352501740
	Mains Input Unit - Schaffner FN372			550001480
Socket	Red 4mm			352501470
Socket	Black 4mm			352501480
Socket	Green 4mm			352501490
Socket	Blue 4mm			352501710
Socket	Yellow 4mm			352501720

## 7. POWER SUPPLIES

The power supply components are distributed between PCB 1, PCB 22 and the rear panel, refer to the appropriate parts list.

## 8. ACCESSORIES

The 7150plus is supplied with the following accessories:

General Description			Schlumberger	
			Part No.	
Mains cable (UK)			359900380	
Mains cable (USA & Canada)			359900390	
Mains cable (Europe)			359900250	
Mains cable (Other)			480140220	
Set of test leads and probes			359900360	
Calibration Jack plug			351302120	
Calibration Overlay			71502070A	
5-Pin Din Plug			351305070	
Fuses	Slow Blow	100mA	Glass 20 x 5 mm	360106260
	Fast blow	2A	Glass 20 x 5 mm	360100150
	750VDC	250 mA	Glass 1.25 x 0.25	360103050
Fuse Holder Size 0		1.25 x 0.25		360208150
Operating Manual				71500024

## 9. OPTIONS

The following Options are available for 7150plus:

Radio Frequency Probe	70457F
High Voltage Probe	70457E
Current Shunt	70457X
Temperature Probe, Insertion	71517A
Temperature Probe, Surface	71517B
Rack Mounting Kit	71501
Maintenance Manual	7150026
Nato Connection Set	71517C
Carrying Case	71509A

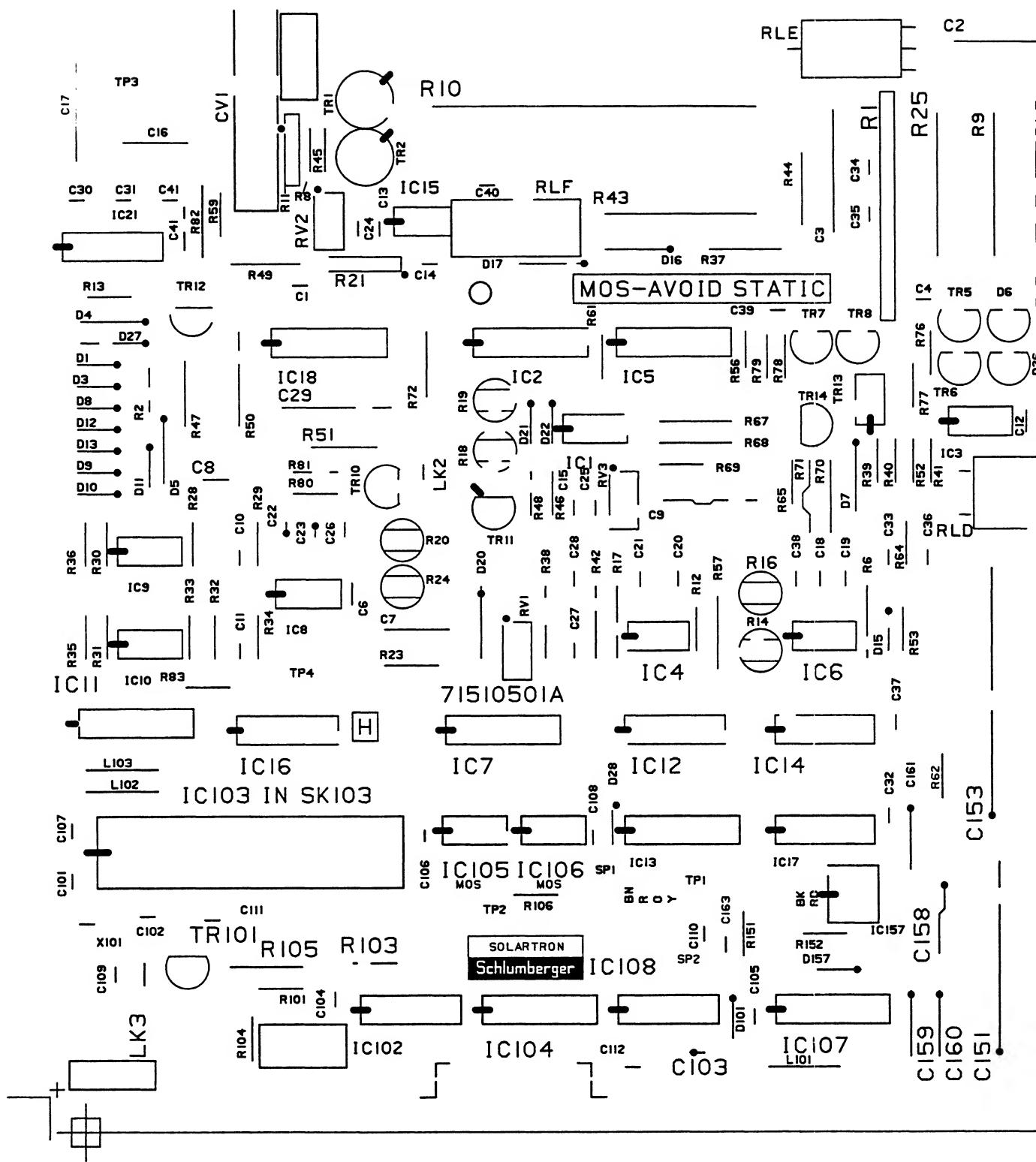
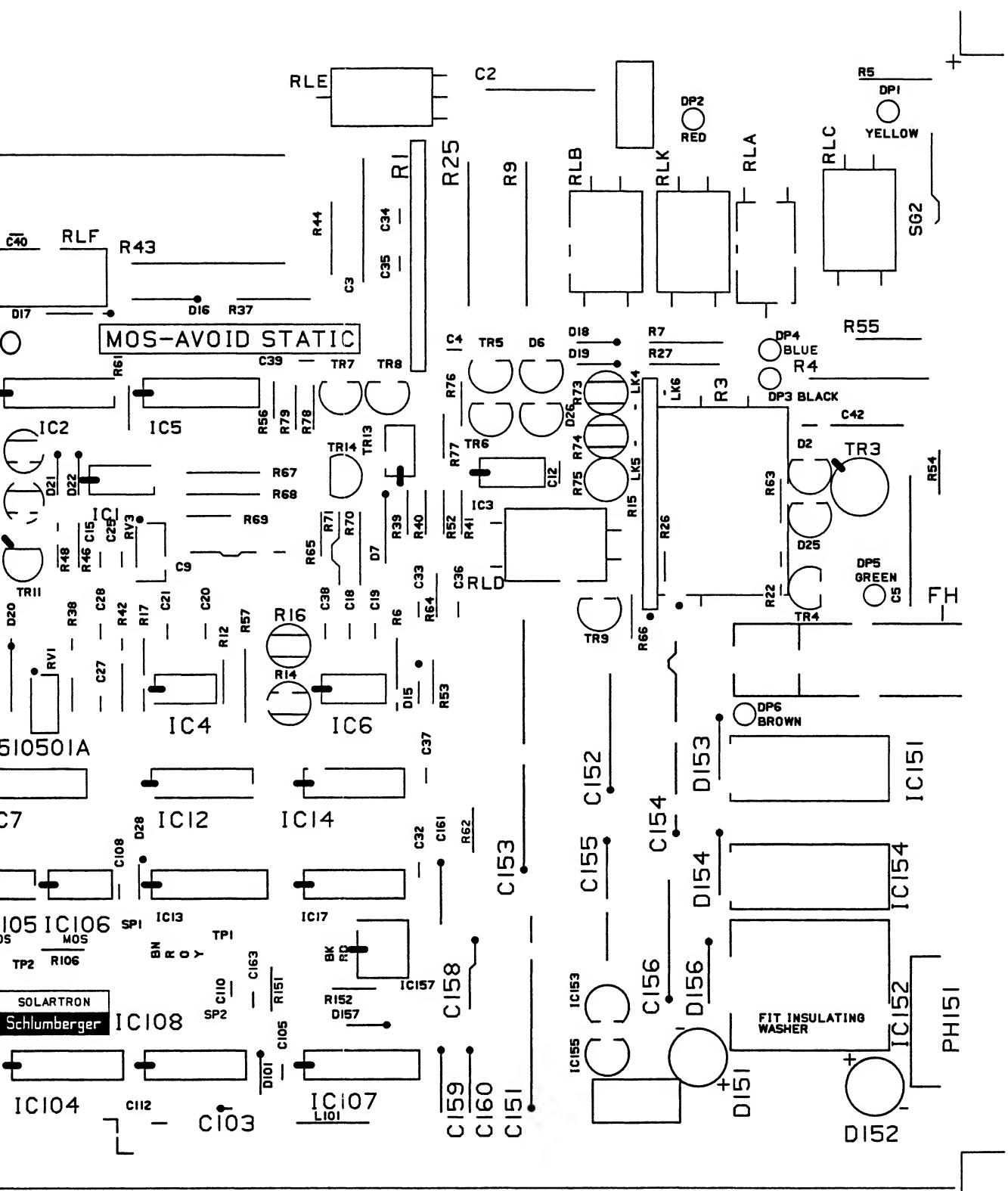


Fig 5.



**Fig 5.1 PCB 1 COMPONENT LAYOUT**

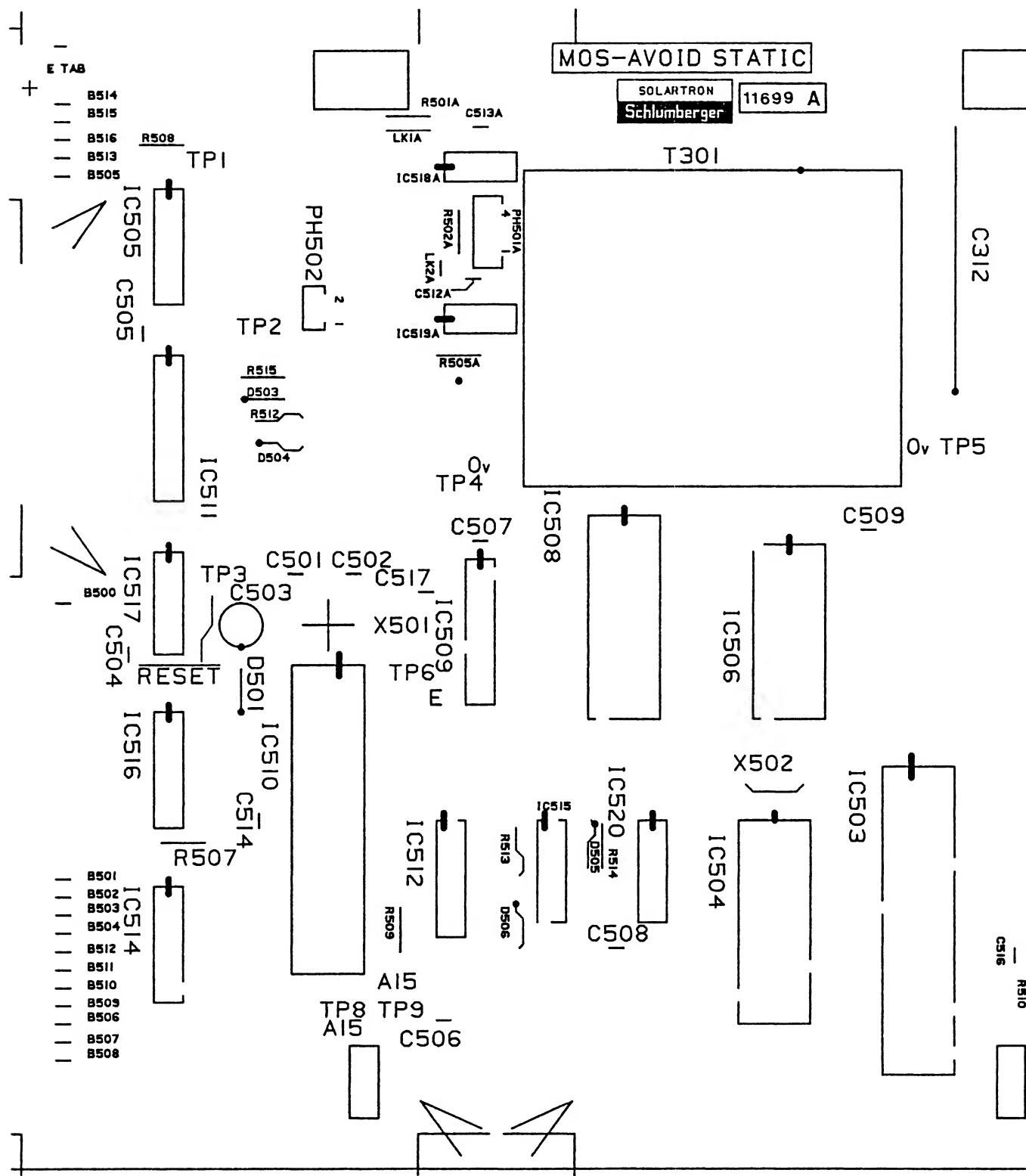


Fig 5.2

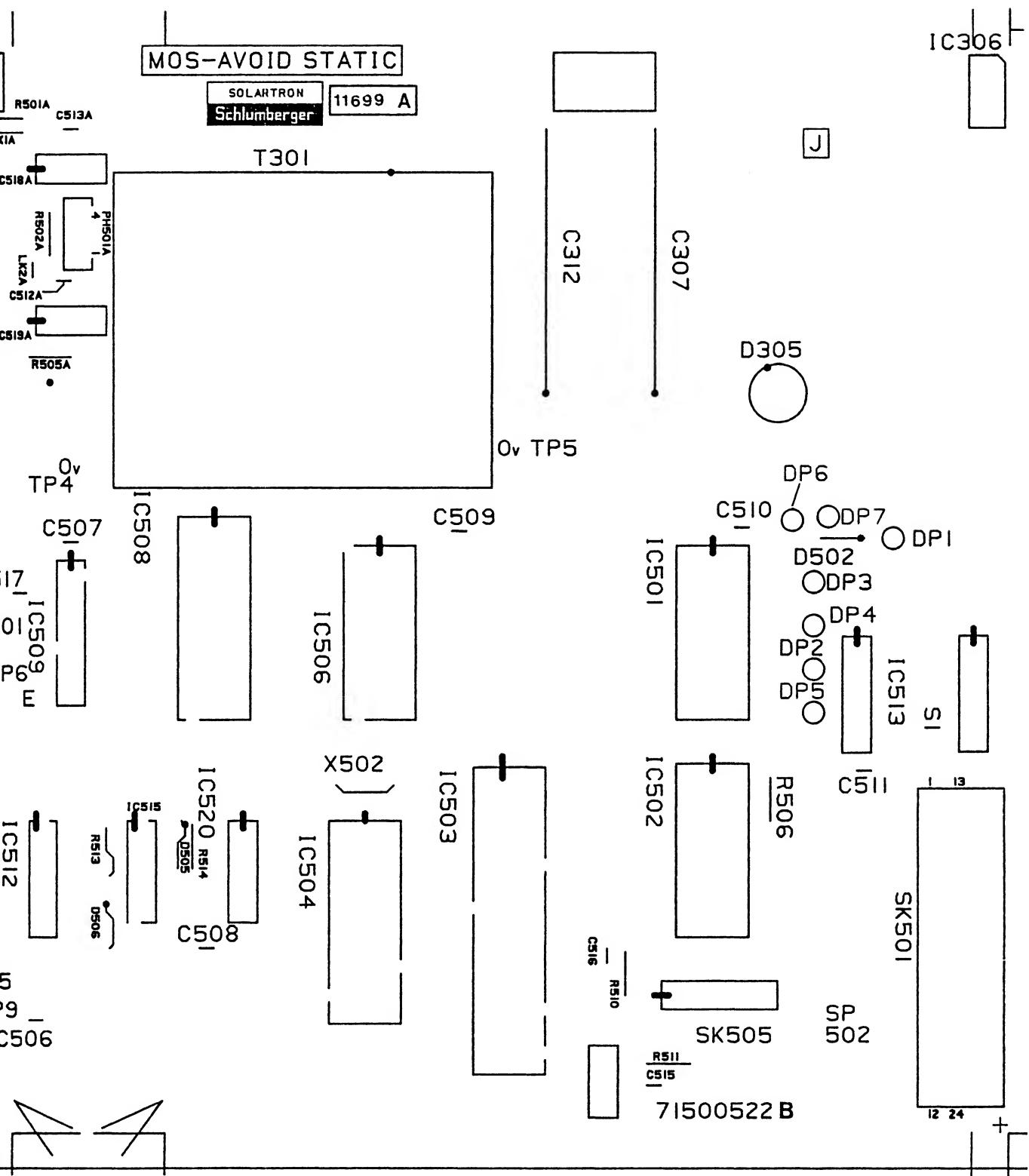


Fig 5.2 PCB 22 COMPONENT LAYOUT

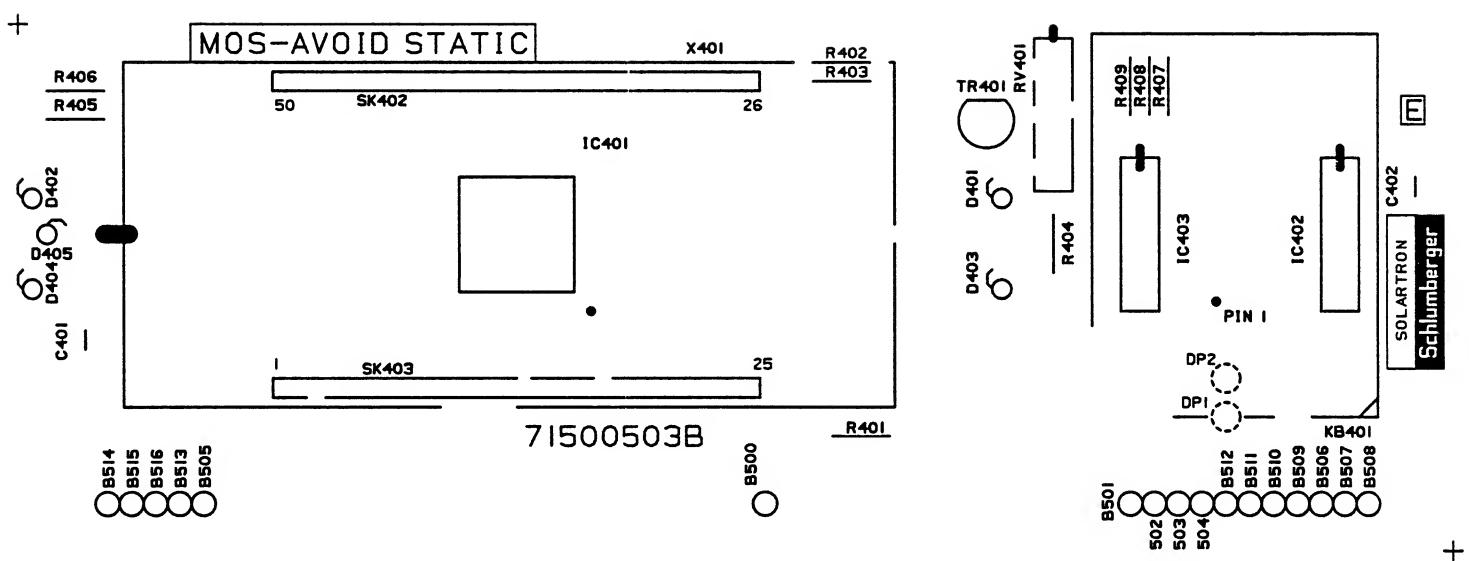
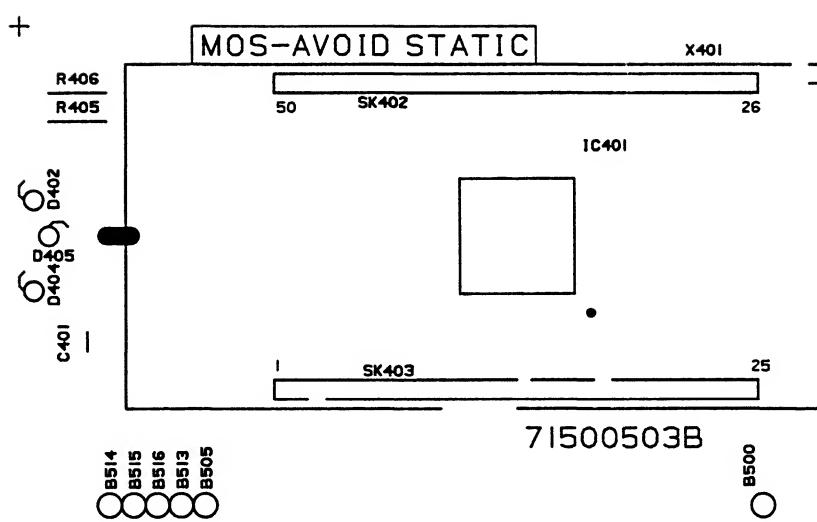


Fig 5.3 PCB 3 COMPONENT LAYOUT



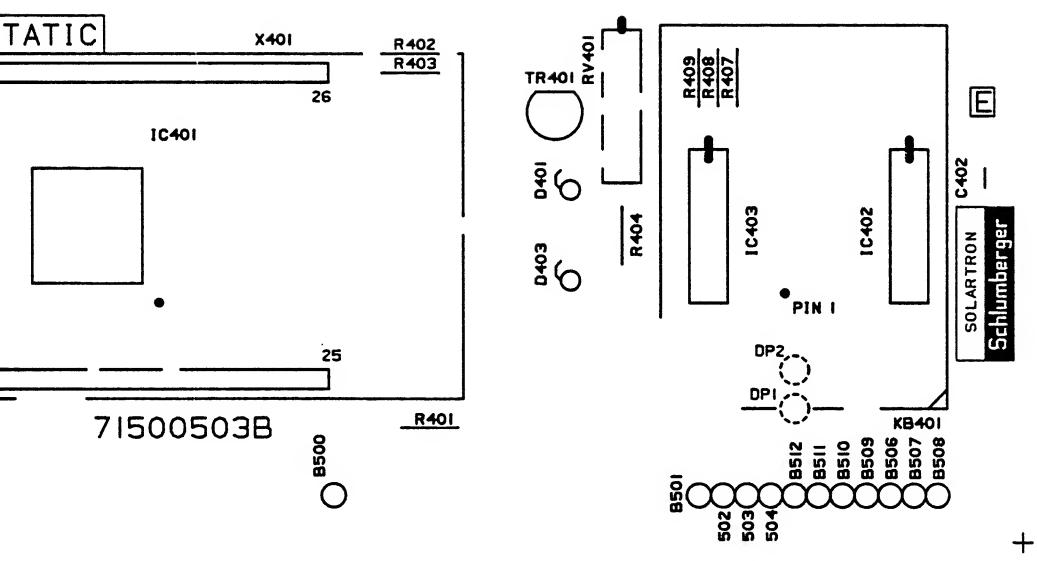


Fig 5.3 PCB 3 COMPONENT LAYOUT

# Chapter 6

## Fault Diagnosis Guide

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<i>Section</i>	<i>Page</i>
1 General	6.3
2 GP-IB	6.4
2 Pcb 22	6.4
3 Pcb 1	6.5



## 1. GENERAL

Symptom	Possible Fault	Procedure
Instrument 'dead'	No Mains power	A good check is to look for the display back lights. If no lights, check fuses and supply voltages.
Fuses keep blowing	Rectifier, regulator or smoothing capacitor faulty	<p>Check current drawn from mains for 240V on 240V setting (approx. 60mA) and for 120V on 120V setting (approx. 120mA).</p> <p>Under fault conditions, eg, regulator blown, current may be typically 500mA. Look for correct output from each regulator IC.</p>
'Fail 1' displayed on power-up.	Communication breakdown between floating and earthy logic.	<p>Check opto-couplers IC518 and IC519, IC 102 and the connecting wires and plugs (to pcb 1).</p> <p>Check for activity on the TX and RX lines.</p>
'Fail 3' displayed on power-up.  [Note Fail 2 is not applicable to 7150plus]	Internal RAM failure	Check IC506 and its connections .
'Fail 4' displayed on power-up.	PROM failure	Check IC508 and its connections.
Amps range inoperative	2A fuse on rear panel blown.	Check fuse.
Display inoperative	Poor connections between display and IC301.	Check LCD pin connections in sockets and ensure good contact.
Display sluggish or too faint	Contrast setting needs adjustment.	Check setting of RV 401
Calibration routine completed but DMM still out of calibration	New cal. constants have not been stored in ICs 105 and 106	Check that -25V is produced by IC157 pin 5 when cal. plug is fitted and that it reaches ICs 105 and 106 pin 1.

## 2. GP-IB

Symptom	Possible Fault	Procedure
GP-IB inoperative	Wrong switch setting	Ensure GP-IB switch (S1) is switched ON and that the desired address is set (Switch power OFF, then ON and observe displayed IEEE address).
	Faulty switch contacts on S1.	If no address appears after carrying out the above, toggle the switches several times, to clear contacts then try switching OFF/ON again.
GP-IB Intermittent operation.	DMM set to same address as another bus devices.	Ensure each device (including controller) has a unique address
	Poor connections	check GP-IB sockets and cables for good connections. Check that socket pins are not damaged.

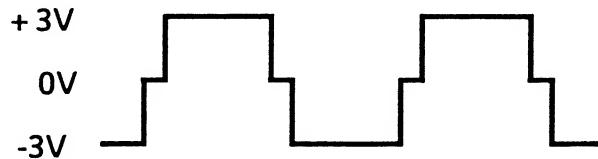
It is possible that a fault will not fall into one of the above categories and it will be difficult to decide where to start looking; however, for pcb 1 and pcb 22 there are some basic checks that can be carried out to help narrow the search.

## 3. Pcb 22

1. Check all power supplies are within tolerance. (See Chapter 3)
2. Check that waveform E at IC510, pin 40 is a 1.2288MHz square wave.
3. Check that the RESET line is high.
4. Check that there is activity on the TX and RX lines between pcbs 1 and 22 (via opto-couplers) at IC510 pins 11 and 12. (See 'Fail 1')

#### 4. PCB 1

1. Check all power supplies are within tolerance. (See Chapter 3)
2. Check that waveform E at IC103, pin 40 is a 1.2288MHz square wave.
3. Check that the RESET line is high.
4. Check that there is activity on the TX and RX lines between pcbs 1 and 22 (via opto-couplers) at IC103 pins 11 and 12. (See 'Fail 1')
5. Apply a short circuit to the voltage input terminals, then check the waveform from IC16 pin 10 at TP4 which should resemble the following:



If there is no waveform, then check the ADC comparator outputs and reference voltages. The ADC forcing waveform of 300Hz is generated by IC103 pin 9. The reference voltages at IC16 pins 6 and 9 should be -3.1 and +3.1 respectively.

